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CONTENTS

RESEARCH – to do or not to do that is the question!

Minichello, Sullivan Greenwood and Axford[1] define research as "to search again or to examine carefully , more specifically research is a rigorous, systematic enquiry or investigation, and its purpose is to validate and/ or refine existing knowledge and to generate new knowledge." This process in reality develops the need to collect, organise and present information to enable analysis and interpretation and arrive at outcomes. Research outcomes may change the way in which patients are managed, services are modified or are not delivered.

As Orthoptists practice in a wide range of clinical settings these settings provide opportunities to collect data that will support the management of patients with vision defects, implement treatment regimes and review current developments in the fields of eye care. How can conventional practice become research? Apart form the gold standard, double blind randomised studies, consider the following research strategies:

1. Turning a quality assurance project into a publication. Many practitioners are required to review their work practise within specified guidelines and stae outcomes. Other practitioners review their skills as part of an ongoing self - evaluation. Both approaches can be modified to provide a research presentation that can be of benefit to colleagues and the profession more widely.
2. Use an interesting case as a single case analysis to show change over time or variation from the considered "norm". An interesting clinical case can be used as an educational tool to refresh, update, re-evaluate ones own clinical practice or inform another profession. Take for example a "garden variety" amblyopia case where the treatment pattern seems set according to age or condition, a review of the literature may reveal recent changes in approach which , when implemented in a patient, produce significant and effective results. The same case may be used to educate General Practitioners.
3. Practice informing research which includes an overview of a professional skill area, particularly across several years, can be of value in many ways. For instance areas where practitioners interact with other disciplines and impart knowledge about the relevance of vision defects in patient survival. A review of professional experience across several years can demonstrate how practice has changed and remind practitioners of the reasons for current approaches.
4. Participate in group research, pool your resources to have a larger data set, become part of a research team, have a research mentor to brain storm ideas, collaborate co-author a paper and collect data with another colleague or profession. "If research-based knowledge is to become the basis for client care, there must be direct involvement by health care professionals at all levels of preparation and experience"[1].
5. One way of addressing persistent concerns is to explore, probe or scrutinise the concern to enable the development and implementation of a solution. This process can be initiated through a systematic review of past and current literature using thematic analysis which forms the basis of a literature review.
6. Commenting on public health issues for instance cancelling Pre-school vision programmes. Issues such as this require the review of literature and research into health management and policy in order to develop a sound argument. Often the end result is a letter that summarises the salient issues. The wider literature base can be usefully turned into a publication that informs the profession.

The research process often appears to be daunting or for members of the profession who are inspired to research.

This journal edition demonstrates several research models that clearly reveal how solid efforts of enquiry enable professions to move ahead, and deliver evidence based clinical practice.

Neryla Jolly

Kathryn Thompson

Reference:

1. Minichello, Sullivan Greenwood and Axford 2004 Research Methods for Nursing and Health Sciences Prentice Hall

Is Tropicamide a More Effective Cycloplegic than Cyclopentolate in Children with Dark Irides?

Authors:
Nick Jones, BOrth
Dr Khoo Boo Kian, MBBS, MMed, FRCS
Olivia Chng, DipOptom
Sherlene Kee, BOrth
Koo Huey Ming, BOptom

Address for Communication:
Nick Jones
Vision Australia
Cobb Rd Mt Eliza VIC 3930
AUSTRALIA

ABSTRACT

Background: Cycloplegia of dark irides is commonly achieved using a combination of cyclopentolate (1%) and tropicamide (1%). To date, no studies have compared the use of a cyclopentolate/tropicamide combination with the use of tropicamide alone to determine whether the cyclopentolate is necessary in dark irides. In addition this is the first study to use the interval between drops as a variable for cycloplegic effect.

Methods: We compared 4 different drug regimens - cyclopentolate plus tropicamide with 10 second interval (cyclo/trop), tropicamide plus tropicamide with 10 second interval (trop/trop), cyclopentolate plus tropicamide with 5 minute interval (cyclo/5min/trop) and tropicamide plus tropicamide with 5 minute interval (trop/5min/trop). The different cycloplegic regimens were administered to 174 Singaporean Chinese children aged between 3 and 12 years old.

Results: The 4 treatment groups all had similar differences in autorefraction after cycloplegia (mean 0.4D), with a slightly larger (but not statistically significant) difference with the 'trop/trop' combination. Residual accommodation measured by the 'push-up' method was least in the 'cyclo/5min/trop' group, followed closely by 'trop/cyclo'. The 'trop/trop' group had an average of 0.8D more residual accommodation than 'cyclo/5min/trop'. This was statistically significant, p=0.035).

Conclusions: Tropicamide (1%) is safer and faster acting than cyclopentolate (1%). In people with dark irides it has a superior mydriatic effect and similar cycloplegic effect. The authors suggest that clinicians consider substituting cyclopentolate combinations with 2 drops of tropicamide for maximum cycloplegic effect in Chinese children and other races with dark irides in cases where atropine is not required.

Keywords: tropicamide, cyclopentolate, Chinese, cycloplegics, accommodation

INTRODUCTION

The introduction of cyclopentolate in the early 1950s ousted atropine as the drug of choice for routine cycloplegic refraction[1,2,3,4]. It produced rapid cycloplegia and mydriasis that lasted significantly less time than atropine. At the original 2% concentration it commonly caused CNS effects[5,6,7,8] but at 1% concentration the side effects were tolerable without a significant loss of effectiveness[4]. The more common side effects include However, even at the 0.5% level side effects such as unsteadiness, confusion, constipation, fast heartbeat, red face and hallucinations have been reported and it has been suggested that many side effects of cyclopentolate go unreporeted because the children do not realise that it is important to mention these effects[9,10].

The cycloplegic and mydriatic effects of cyclopentolate are not as effective in people with dark irides as they are in light irides[3,11]. Its mydriatic effect is particularly poor and so tropicamide is often added to cyclopentolate to ensure adequate mydriasis[12]. This addition of tropicamide has been found by some authors to enhance the cycloplegic effect. Miranda found that adding tropicamide to cyclopentolate resulted in similar residual accommodation in dark irides as cyclopentolate alone had on light irides[11]. Lin and co-workers compared the difference between cycloplegic refractions and found that in Chinese eyes, tropicamide was more effective and furthermore that adding cyclopentolate to tropcamide only increased the effect by 0.1D[13]. Another study similarly found (in light irides) that two drops of 1% cyclopentolate resulted in similar residual accommodation as two drops of tropicamide[14].

Atropine is often thought to be the gold standard for cycloplegia[14,15]. However, while no studies have claimed that other cycloplegics are as effective as atropine, several comparison studies (including one on dark irides) with cyclopentolate and cyclopentolate/tropicamide combinations have found approximately 0.35 D difference in post-cycloplegic refractions, with between 8 - 22% having more than 1D difference[12,16,17,18]. The suggestion arising from these studies is that atropine is preferable in hypermetropes greater than 2D and esotropes but that other children can safely be refracted with the shorter-acting cycloplegics.

In addition to the choice of drug, the other factor thought to influence the effectiveness of cycloplegia is the time between instillation of drops. Pilocarpine studies on both animals and humans have indicated that waiting at least five minutes between drops is necessary due to slow drainage of eye drops[19, 20, 21]. However, Geyer and co-workers found that there was no difference in mydriatic effect if 2 mydriatic drops were instilled 10 minutes apart or immediately following each other[22]. A later study found no difference in the mydriatic effect of cyclopentolate instilled at 1 minute compared to 5 minute intervals[23].

From these studies it can be seen that cyclopentolate and tropicamide are effective cycloplegic agents, though with slightly reduced effect in patients with dark irides. There is an increasing body of evidence suggesting that in dark irides, when cyclopentolate/tropicamide combinations are used, the cyclopentolate may be having less cycloplegic effect than the tropicamide[11,13,14]. However, the best combination of drops has yet to be determined. This is important to resolve because there are potentially more severe side effects with cyclopentolate, particularly with increased dosage. In addition this is the first study to use the interval between drops as a variable for cycloplegia.

The aim of this study was to determine whether tropicamide alone was superior to a cyclopentolate/tropicamide combination and to determine whether a 5 minute interval has a greater benefit that a 10 second interval.

METHOD

This prospective study was conducted in an outpatient clinic in Singapore. We studied consecutive children sent for cycloplegic refraction. To be included, the child needed to be responsive for subjective refraction and capable of doing autorefraction. Many could not understand the accommodation test but these patients were still included, as we were interested in their autorefraction data as these children represent a large proportion of our patients for cycloplegic refraction. The majority of Singapore's population is Chinese with smaller groups of Malays and Indians. For ease of data analysis we only studied the Chinese children. Patients or their parents were asked to self-designate race.

The study included 132 children aged between 3 and 12 years old with refractive error between +3D and -10D, refracted between 30 and 60 minutes after the last drop was instilled. Children with anisometropia of more than 2.5D or with strabismus were excluded. There were 17 exclusions - 10 were due to high refractive error, 5 due to anisometropia, and 2 to strabismus. 55% were males and 45 % females. Only data from the right eye was used. See Table 1.

Table 1. Demographics

regimen	mean autorefraction (range)	age (range)	mean time†	excl ‡
cyclo / trop 45 eyes	-1.9 (+3.8 to -8.4)	6.0 (3 -12)	41 min	6.5%
cyclo/5min/trop 42 eyes	-1.2 (+1.25 to –6.4)	5.5 (3 -10)	40 min	4.7%
trop / trop 45 eyes	-1.7 (+3.4 to –6.1)	5.8 (4 -10)	43 min	4.8%
trop /5min/ trop 42 eyes	-1.7 (+0.63 to -7.5)	5.7 (3 -10)	42 min	5.5%

† mean time between instillation of last drop and autorefraction
‡ percentage of patients excluded

Patients were given combinations of Alcaine (Alcon Laboratories - proparacaine 0.5%), Cyclogyl (Alcon Laboratories - cyclopentolate 1%) and Mydriacyl (Alcon Laboratories - tropicamide 1%). We uniformly used proparacaine for all patients, because even though there is some doubt whether it aids absorption, it makes the test more comfortable and reduces crying[24].

Four experienced optometrists and orthoptists measured autorefraction and accommodation. The difference in autorefraction after cycloplegia provides the most objective and clinically relevant indication of cycloplegic effect. Autorefraction was measured on the Canon RK5. Five or more measurements were taken and the suggested refraction by the machine was recorded. Spherical equivalent of this result was used for comparisons.

Accommodative amplitude was measured using the RAF rule by the push-up method with the patient wearing best-corrected distance correction after subjective refraction with fogging. The near point was recorded as the point where the patient first noticed that the reduced Snellen 6/12 line was blurred.

There were four regimens designed to determine whether drug combination or time between drugs would effect cycloplegic effect. Each drug regimen was used during a period of two months corresponding to school vacation times. The patients were not randomised and the examiners were not blinded due to insufficient time and resources. However, as autorefraction is an objective test it should not be biased by these factors. The accommodation tests could potentially be biased but the investigators thought it still important to attempt to quantify the depth of cycloplegia. By using strict protocols this bias was minimised.

The 4 groups were:

1. **cyclo/trop** (45 eyes): 1 drop proparacaine, 1 drop cyclopentolate, 10 seconds, 1 drop tropicamide
2. **cyclo/5min/trop** (42 eyes): 1 drop proparacaine, 1 drop cyclopentolate , 5 minutes, 1 drop tropicamide
3. **trop/trop** (45 eyes): 1 drop proparacaine, 1 drop tropicamide , 10 seconds, 1 drop tropicamide
4. **trop/5min/trop** (42 eyes): 1 drop proparacaine, 1 drop tropicamide, 5 minutes, 1 drop tropicamide

RESULTS

The difference in autorefraction was similar for all regimens. The trop/trop combination showed the biggest difference (0.44D), with 33% of their eyes having more than 0.5D difference. The least difference was the trop/5min/trop group (0.32D). There was no statistical significance between groups with ANOVA test. See Table 2

Table 2. Means of the Differences in Autorefraction Before and After Cycloplegia and Percentage of Eyes with a Mean Difference Greater than +0.5D or +1.0D.

drug regimen	mean difference (+/- SD)	difference > +0.5D	difference > +1.0D
cyclo / trop 45 eyes	+0.36 (+/- 0.56)	27%	7%
cyclo/5min/trop 42 eyes	+0.41 (+/- 0.59)	29%	10%
trop / trop 45 eyes	+0.44 (+/- 0.41)	33%	2%
trop /5min/ trop 42 eyes	+0.32 (+/- 0.38)	21%	2%

Residual accommodation did not follow the trends of autorefraction. The cyclo/5min/trop group showed the least residual accommodation (2.8D), with 32% of these eyes having more than 3D of residual accommodation. Interestingly, the trop/trop group, which had the biggest difference in autorefraction, had the largest amount of residual accommodation (4.0D) and 57% of these eyes had more than 3D of accommodation. See Table 3.

Table 3. Mean Accommodation Before and After Cycloplegia and Percentage of Children with more than 3D Residual Accommodation.

drug regimen	mean accommodation		mean post-cyclo accommodation >3D
	pre-cycloplegia	post-cycloplegia (range)	
cyclo / trop 22 eyes	12.5	3.2 (1.5 – 8)	27%
cyclo/5min/trop 25 eyes	13.4	2.8 (1.5 – 6)	32%
trop / trop 23 eyes	13.8	4.0 (2 – 9)	57%
trop /5min / trop 22 eyes	13.3	2.9 (1.5 – 6)	32%

There was a significant difference in residual accommodation between the cyclo/5min/trop group and the trop/trop group (ANOVA p=0.035) but not between any other groups.

DISCUSSION

This study supports previous research indicating tropicamide alone is as effective combinations of tropicamide and cyclopentolate for cycloplegic refraction13. It also supports the contention that for cycloplegic refraction, the time between drops is not clinically significant[22,24].

The results raise some questions as to why we are using cycloplegia and our methods for measuring how deep the cycloplegia is. The two most common measures of cycloplegic effect - autorefraction and residual accommodation did not correlate in this study and in a previous study actually showed a negative correlation[14].

When compared on the basis of difference in autorefraction, the combination that historically would be regarded as least effective (2 drops of tropicamide with 10 second interval) was at least as effective as the other combinations. However the difference between this combination and the poorest performing combination (trop/5min/trop) was only 0.12D and not statistically significant. This result does not suggest that a better cycloplegic result can be achieved with a smaller time interval but rather that increasing the time interval is of questionable usefulness.

When residual accommodation was used as a measure of cycloplegic effectiveness, the trop/trop regimen performed most poorly and was the only combination to have a statistically significant difference when compared with the most effective regimen (cyclo/5min/trop).

The results of this study could now be used in the determination of drug regimens for eye clinics. In contrast with other studies, this study has compared the most commonly used drug regimens by varying the drug type and time interval. In Chinese children with dark irides there is no evidence that drug combinations involving cyclopentolate are more effective than tropicamide alone. In addition, this paper adds weight to several other studies that indicate that it may not be necessary to wait more than a few seconds between eye drops to achieve satisfactory cycloplegia.

In summary, two drops of tropicamide 10 seconds apart seems to provide an effective, practical, safe, faster-acting and more comfortable alternative to the more traditional regimens used for cycloplegia of children with pigmented irides. However, the authors also support the contention that atropine is preferable for cycloplegic refraction of hypermetropes greater than 2D and esotropes.

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The Standard of Vergence Eye Movements in Children with Reading Difficulties

Author:
Jan E. Wulff, MAppSc(Orth) DOBA MOAA

Address for Communication:
School of Applied Vision Sciences
Faculty of Health Sciences
University of Sydney
PO Box 170 Lidcombe NSW 2141
AUSTRALIA

ABSTRACT

Children with reading difficulties frequently present with reduced vergence ability. This study investigated the visual status of 94 children aged 8 to 10 years old, 53 who read at the appropriate level for their age or better and 41 who read at least 6 months behind the level for their age.

The children were assessed using the GAP reading test, followed by a full orthoptic assessment that included visual acuity, cover test for near and 6 metres, ocular movements, accommodation, stereopsis, reference eye, hand and eye dominance as well as eight measures of vergence and the results were compared between the two groups using a two factor analysis of variance.

The results showed a small but significant reduction in fusional divergence in the reading difficulty group measured with the prism bar for near ($p = .005$) and distance ($p = .024$) and fusional convergence for distance ($p = .030$). The results also showed a significant difference for hand dominance ($p = .038$) with more left handed subjects in the reading difficulty group. There were no significant differences between the two groups on all other measures. Prism fusion range measurements for near and distance should be included in the routine orthoptic evaluation of children with reading difficulties.

Keywords: convergence, divergence, reading difficulty.

INTRODUCTION

Children with reading difficulties often complain of symptoms of eyestrain and frequently present clinically with reduced vergence ability[1,2]. Despite treatment to improve visual symptoms being given to many children with reading difficulties, there have been few controlled studies to ascertain if these children do have reduced visual standards compared to children in the same population who are reading at the level appropriate for their age. This study is using the bench mark that a child has reading difficulties if their reading ability is at least six months behind the standard reading level for their chronological age as assessed by the classroom teacher using the GAP reading test.

The purpose of this study is to determine whether there is any relationship between reading difficulties and clinical measures of vergence or the visual factors of visual acuity, cover test, ocular movements, accommodation, stereopsis, reference eye, hand and eye dominance.

Gender and Reading Difficulties

Studies of the effect of gender on reading difficulties have indicated a higher incidence in male subjects than female. This has ranged from 2:3 to 4:5, depending on the study [3]. However a population study of 5,718 children in Minnesota[4] found that boys were two to three times more likely to be affected than girls. Eden, Stein, Wood and Wood[5,6] consider that there are no significant differences for gender.

Comparative studies of visual defects between normal readers and children with reading difficulties.

The following studies have found no difference in ocular findings between the normal readers and those with reading difficulties. Of the 3,000 seven year old children screened in Bergen[7] 8% of the group were found to have dyslexia, but it was found that the ocular status was almost the same among the normal reading children and those with dyslexia. Helveston's study[8] assessed the visual function and academic performance of 1,910 children and found there was no relationship between the two. Visual acuity was normal (20/30 or better) in 94.2%, convergence near point was 10 cm or less in 98%.

A Melbourne study[9] by Kiely, Crewther and Crewther found no significant correlation between reading ability and the visual parameters of refractive error, amplitudes of accommodation, convergence near point and heterophoria. A Canadian study by Letourneau[10] also found there was no significant difference between children who showed convergence insufficiency and those who did not with regard to school results. Other studies have found some subtle differences between the two groups. In the USA a study by Benton[11] over seven years found that 22% of dyslexic children and 4% of good readers had a reduced convergence near point (more than 5 cm from the base of the nose). An extensive study in Finland (Latvala)[12] found that there was no significant difference between a group of 55 dyslexics and 50 normal readers for visual acuity, cycloplegic refraction, amount of heterophoria and heterotropia, stereoacuity, fusion or accommodation. However there was a significant difference ($p= 0.0385$) in the convergence near point between the two groups, when a convergence near point of 8 cm or worse was used to define reduced convergence.

Eden, Stein, Wood and Wood[5,6] using infrared oculography measured convergence and divergence on the Synoptophore and demonstrated that convergence was not significantly different between normal subjects and those who had a reading disability. However they found that there was a significant difference between the two groups when divergence was measured, this led to an assumption that binocular divergence was the best predictor of poor reading.

A similar study by Lennerstrand from Sweden[13] matched poor readers (low reading ability but normal or above normal cognitive capacity) with regard to class, age, sex, and cognitive capacity with normal readers from two separate age groups (Group A 8-9 year olds, Group B 11-12 year olds). There were 86 matched pairs in Group A and 40 matched pairs in Group B. This study found a significantly lower level of visual acuity in

the poor readers than normal readers of Group A, with 94% of controls with a distance visual acuity of 20/20 or better and only 83% of poor readers. For near acuity of 20/20 the control group had 99% and the poor readers 87%. Cover Test Near showed no significant difference between poor and normal readers, however they found that esophoria at near was more common in controls than dyslexics. The prism fusion range for convergence and divergence measured for near was not significantly different between normal and poor readers. However the fusion range on the Major Amblyoscope revealed a significant difference between the two groups in Group B, with the dyslexic group showing a slightly higher divergence range (p= 0.04).

Relationship between reading difficulties and reduced vergence ability

Atzmon[1] considered that some causes of reading disability were due to a lack of sufficient relative fusional vergence. Treatment to improve this function was given to 109 children. Following treatment 85% reported an improvement in one or more of reading, concentration, spelling, handwriting and copying from the blackboard. A further controlled study[14] was performed in which 31 pairs of children were matched for intelligence, grade in technical reading, grade in reading comprehension and mean convergence ability. One group was given conventional reading tutoring, and the other was given orthoptic treatment aimed at improving their convergence ability to the same level as the previous study. It was shown that orthoptic treatment to improve convergence amplitudes to 60[Δ] was as effective as conventional in-school reading tutoring treatment in improving reading standards.

Schor and Ciuffreda[2] consider that if the symptoms from convergence insufficiency are not treated they may have long term effects on educational development, career selection and attitude. If this is so, it is important to assess the vergence abilities of a controlled population of normal readers and subjects with reading difficulties to assess if there is a difference in their vergence abilities.

Hoyt states "To date, age-matched controlled studies with standard eye movement recordings are conspicuously few in the literature concerning eye movement abnormalities and the learning disabled child."[15]

The purpose of this study is to examine if there is a link between reading difficulties and different parameters of the vergence system. As this literature review has shown, the factors of gender, visual acuity, cover test 33 cm, cover test 6m, ocular movements, accommodation, stereopsis, reference eye, hand dominance, eye dominance and symptoms as predictors of reading difficulties differed greatly between the studies. As most of these functions form part of a full orthoptic assessment it was decided, for this study, to assess them in a normal reading group and a reading difficulty group to see how they compared with the published literature.

METHOD

A random sample of 94 children from a school population of 8 - 10 years old were tested for reading and visual status including ocular vergence skills. The vision assessment was performed within two weeks of the completion of a regular school based reading skill assessment (GAP reading test). The group consisted of 53 subjects with reading ability matched to chronological age or better and 41 subjects with reading ability at least 6 months behind the standard reading level for their age.

Clinical assessment

The following orthoptic assessment was carried out on each subject without the reading level being known by the examiner.

- Visual acuity using Logmar (csv-1000) acuity test at 8 feet.
- Visual acuity with each eye monocularly using the Moorfields near acuity chart and glasses if they were worn in the classroom.
- Cover tests for near and 6 meters (all subjects with orthophoria or heterophoria were included in the study).
- Smooth pursuit and saccadic eye movements.
- Accommodation and three consecutive measures of convergence using the RAF rule.
- Voluntary convergence.
- Fusional convergence and divergence using the prism bar for near and 6 metres.
- Fusional convergence and divergence on the Major Amblyoscope
- Reference eye[7]
- Stereopsis tested by the Titmus Four Dot test.
- The preferred hand used to write with
- Eye dominance

The data for each subject was entered into a Microsoft Excel computer program and analysed using the Statistical Package for the Social Sciences (SPSS) computer program (version 10.0 for Windows). The eight measures of vergence ability were analysed using two factor ANOVAs. The dependent measures of gender, reference eye, hand dominance, stereopsis and symptoms in relation to reading difficulty status were assessed with chi-square tests. Hand dominance was compared using the Fisher's Exact probability two-sided test. The significance level was set at 0.05.

RESULTS

There were 94 subjects tested who consisted of two groups, one who read at or above the level for their chronological age (n=53) and the other (n=41) who read at least six months behind their chronological age. This allowed for comparisons of visual function and vergence ability between the two groups. Visual acuity on the Logmar chart ranged from - 0.30 to 0.22 in each eye (which is the equivalent of 6/3 to 6/10 (-1) on the Snellen chart). Visual acuity for near was N5 for all subjects. The non vergence results are shown in Table 1.

Table 1. Non vergence results.

		Normal Reading (n=53)	Reading Difficulty (n= 41)	P values
Gender	Male 46	24 (45%)	22 (54%)	.450
	Female 48	29 (55%)	19 (46%)	
Cover Test Near	Orthophoria	49 (92.5%)	40 (97.5%)	
	Esophoria	0	0	
	Exophoria	4 (7.5%)	1 (2.5%)	
Cover Test 6m	Orthophoria	53 (100%)	41 (100%)	
	Esophoria	0	0	
	Exophoria	0	0	
Ocular Movements	Normal Pursuits	51 (96%)	41 (100%)	
	Abnormal pursuits	2(4%)	0	
	Normal Saccades	53 (100%)	41 (100%)	
	Abnormal Saccades	0	0	
Accommodation	Normal	52(98%)	39 (95%)	.444
	Abnormal	1 (2%)	2 (5%)	
Voluntary Convergence	With Vol. Conv.	38 (71.7%)	25 (61%)	.4846
	With no Vol.Conv.	13 (24.5%)	15 (36.5%)	
	Indeterminate Vol.Conv.	2 (3.8%)	1 (2.5%)	
Symptoms	Nil	48 (90.6%)	34 (82.9%)	.371
	Slight	5 (9.4%)	6 (14.6%)	
	Moderate	0	1(2.5%)	

There was no significant difference in results between the two groups for any of the visual tests in the above table. The eye and hand related results are shown in **Table 2.**

Table 2. Eye and Hand related results. Test		Normal reading (n=53)	Reading difficulty (n=41)	P values
Reference Eye	Right Eye	27 (51%)	16 (39%)	1.475
	Left Eye	22 (41.5%)	20 (49%)	
	Unstable	4(7.5%)	5 (12%)	
Hand Dominance	Right Hand	49 (92.5%)	31 (75.6%)	.038
	Left Hand	4 (7.5%)	10 (24.4%)	
Crossed Dominance	Crossed	27 (50.9%)	15 (36.6%)	.165
	Uncrossed	26 (49.1%)	26 (63.4%)	
Eye Dominance	Right Eye	41(77.3%)	33 (80.5%)	1.000
	Left Eye	11 (20.7%)	8 (19.5%)	
	Unstable	1 (2%)	0	

P bold indicates a significant result.

The reference eye and hand dominance tests were compared to give the crossed or uncrossed dominance results. The hand dominance between the two groups was significant (p= .038, using the Fisher's Exact probability two sided test) with more left handers in the reading difficulty group. There was no significant difference for eye dominance or reference eye. The vergence and stereopsis results are shown in Table 3.

Table 3. Vergence and stereopsis results.

		Normal Reading Group		Reading Difficulty Group		P values
		Mean	S D	Mean	S D	
RAF rule conv	1st	5.5 cm	1.2	5.7 cm	1.2	.290
	2nd	5.5	1.2	5.9	1.4	.251
	3rd	5.7	1.5	5.9	1.5	.380
Prism Fusion Range Near	Conv	25	8.8	22.3	7.8	.165
	Div	10.2	2.3	8.9	1.9	.005
Prism Fusion Range Distance	Conv	9.0	2.5	7.9	2.2	.030
	Div	7.0	2.3	6.0	1.7	.024
Major Amblyo-scope	Angle	-.5 prism dioptres	1.1	-.4	.7	.526
	Conv (blur)	19.5	7.1	20.2	6.4	.599
	Conv. (break)	47.8	19.9	46.6	22.1	.795
	Div	10.5	2.1	10.1	1.4	.244
Stereopsis(Titmus)		71.5	116.2	53.9	31.1	.407
Vol Conv						.485

P bold indicates significant result.

A comparison of the vergence results between the two groups indicated that there was a small but significant difference on the measures of base in prism fusion range for near (p = .005) and far (p = .024). and base out prism fusion range (p = .030) for far. RAF rule convergence was measured three consecutive times and there was a significant difference (p = .024) of reducing convergence ability between the three measures in a linear relationship for the total population but no significant difference between the two groups.

DISCUSSION

These results confirm that there is no significant relationship between reading ability and reduced vergence or fusional amplitudes as measured with the RAF rule, prism bar convergence for near, the Major Amblyoscope or measures of voluntary convergence. There was also no significant difference in gender, visual acuity, cover test, accommodation, stereopsis, eye dominance or reference eye which could account for poor reading ability.

There was a significant difference (p = .038) between the two groups in hand dominance with more left handed subjects in the reading difficulty group. This finding is consistent with the previous study of Brown[16] who found the proportion of left handers was almost twice as high as the normal population. In the studies of Stein et al.[5,6] there was no significant difference in handedness between the normal readers and reading disabled groups. Left handedness has a higher incidence in subjects with reading difficulties.

The results that showed a statistical significance between the two groups in vergence ability were divergence measured with the Prism Bar for near and convergence and divergence measured with the Prism Bar for 6 metres. When the mean and standard deviation measurements for these are compared there is not a great deal of clinical difference, approximately one prism dioptre. This would indicate that clinically a difference between the two groups may not be noticed. This difference may be more demonstrable in a larger sample. The difference

in divergence ability between the two groups (as measured with the prism bar for near) was significant at p= .005 in the present study. Lennerstrand[13] found that the prism fusion range of divergence measured for near was not significantly different between normal and poor readers. The difference in convergence (p= .030) and divergence (p=.024) ability of the reading difficulty subjects was also significant compared to the normal readers when measured with a prism bar for 6 metres. Rarely are prism fusion ranges for six metres performed if the vergence mechanism is being assessed and therefore the results can only be compared to the study by Atzmon[14] when prism bar convergence for 6 metres was recorded but no significant difference was found between the two groups.

These findings may suggest that children with reading difficulties have a reduction in their ability to relax their convergence and/or may demonstrate a deficit in the divergence mechanism. The significant difference in divergence ability as measured with the prism bar suggests that these may be determining factors in children with reading difficulties. Most studies rely on Major Amblyoscope recordings for vergence for 6 metres, especially as it is easy and quick to perform vergence measures following the reference eye test. Atzmon[1] agrees that preference should be given to testing convergence amplitudes with loose prisms or a prism bar because prism vergences more closely resemble everyday seeing and avoid "instrument convergence" induced by the Major Amblyoscope.

Atzmon 1 has observed that children with poor convergence amplitudes at distance may have a reading problem despite good convergence at near, with their main problem difficulty copying from the blackboard, however they found no correlation between the near point of convergence and absolute convergence amplitudes measured for distance and near with a prism bar. This study recommended to the Minister of Education in Israel "all dyslectic children also be given an ophthalmologic and orthoptic evaluation, emphasising the testing of prism vergence amplitudes, and with special attention to asthenopic complaints."

CONCLUSION

Prism fusion measurements of convergence and divergence for near and 6 metres should be included in the routine ophthalmic and orthoptic evaluation of all children with reading difficulties. Comparing the results of the present study and others cited in the literature review there was no significant difference between the normal readers and reading difficulty groups for the factors of gender, visual acuity, cover test near, cover test distance, ocular movements, accommodation, stereopsis, reference eye, hand dominance, eye dominance, symptoms and some measures of vergence in the present study. This indicates that these are not significant factors in reading difficulty and reinforces the fact that all children with reading difficulties should have a full assessment and only visual anomalies that are found should be treated, however treatment of these anomalies may not lead to improved reading performance. There were significantly more left handers in the reading difficulty group, confirming other studies that this is a related factor for children with reading difficulties.

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The Effect of Training on Horizontal Saccades and Smooth Pursuit Eye Movements

Authors:
Linda Santamaria MAppSc, DipAppSc (Orth), DOBA
Ian Story PhD, BBSc (Hons)

Address for Communication:
Department of Surgery, Monash University
Monash Medical Centre
Level 5, Block E
246 Clayton Rd, Clayton, VIC 3168
AUSTRALIA

ABSTRACT

Previous studies have shown that eye movement function decreases with age, with pursuit showing more effect than saccades. The aim of this study was to assess whether these age-related changes were reversible with eye movement training.

This study with 28 young adults, 34 older adults and 36 control participants measured the effects of two weeks of training of both saccadic and pursuit eye movements. It was found that training resulted in a significant improvement in smooth pursuit function in both training groups, with the older group showing a greater improvement. No improvement occurred in saccadic function.

These results suggest that the age-related decline in eye movement function may be due to irreversible degenerative changes in the central nervous system. The differential improvement supports the hypothesis that in normal viewing the ocular motor system is maximally stimulated for saccades but not smooth pursuit movement. Eye movement training, by providing extra stimulation, resulted in improved smooth pursuit in both groups to the extent that the age-related decrease in function was reduced but still remained.

Keywords: Saccades, pursuit eye movements, aging, training.

INTRODUCTION

There have been several studies of the effects of training on eye movement responses. Some are in the context of improving function in the presence of ocular motor disorders, either to increase the rate of recovery of ocular motor problems after stroke, or to improve the general ocular functioning in children with cerebral palsy. Others are in the presence of normal ocular function.

One study attempting to demonstrate the effects of training on the recovery of ocular motor palsies reported that the recovery time was shortened, and that there was no transfer between pursuit and saccade training.[1] Abel et al[2] described one case study of a patient with a III nerve palsy where saccadic gain increased, though velocity did not, after occlusion of the good eye, with the changes being direction specific and reversible. Gur and Ron[3] stated that patients who had received training after brain injury showed a significant improvement in pursuit gain at a higher rate than untrained patients, but no details of statistical analysis were provided. These authors then hypothesised that similar results may be obtained in people with a 'small-range tracking capacity', moving from increasing the rate of recovery in those with brain injury to being able to increase the ability in those with a lower normal range of function without any pathological cause.

Duckman[4] described improvement after a visual training program in children with cerebral palsy. A study by Gauthier and Hofferer[5] also reported post-training improvement in pursuit in both children with cerebral palsy and children who were healthy, but those with cerebral palsy did not achieve the same level. There was no change in saccadic velocity, but an improvement in the slow latencies of the children with cerebral palsy, and a decrease in saccadic error for both groups. Another study trained saccadic function in a group of children with dyslexia, reporting that results were dependent on the condition trained with no transfer between tasks. However, the authors were unsure of any actual effect on reading skill as this was not assessed.[6]

Other studies have used visual training in an attempt to determine whether improvement in eye movement function would result in improved performance in other motor areas, in particular in sports achievement. McLeod and Hansen[7] reported improvement in static balance after visual skills training with a videotape program consisting of scanning and saccades. In contrast, Williams and Helfrich[8] suggested that eye movement training may improve eye movements, but that this will not consequently improve sporting performance. Shapiro and Raymond[9] aimed to determine whether specific ocular motor patterns could be trained and whether these influence skill acquisition, raising the concept of task specific strategies and whether training particular task components would have any effect on a complex perceptual motor skill. Other studies suggest that it may be the search strategies, rather than the eye movements themselves that are inefficient in less experienced sportspersons[10] or in the elderly.[11]

Another study tested the hypothesis that if visual training does improve performance, then pilots, because of their extensive visual training, would show improved eye movement performance.[12] As no significant differences in saccadic latency, duration or peak velocity were found, it was concluded that the oculomotor system is maximally stimulated and therefore performance is optimised naturally for all individuals. This result is supported by Hitzeman and Beckeman[13] in a review of the literature on sports vision, who concluded that most researchers suggest that elite athletes have visual skills that are superior to those of non-athletes, but that these were specific to the sport being investigated with little evidence to support the hypothesis that visual training will improve the visual skills.

Only a few studies have trained eye movements in normal subjects and studied the effects. Whittaker and Eaholtz[14] demonstrated post-pursuit eye movements in two subjects, who were trained to continue pursuit movements for more than one cycle after the target had disappeared. Fischer and Ramsperger,[15] in training saccades, concluded that practice can

change the preparation time of saccades, maybe by learning to disengage attention from the fixation target. Elmurr and colleagues reported reduced saccadic reaction times in elite athletes[16] and in a further study reported a significant training effect in non-athletes after a five-week training program, with the greatest effect occurring in the first two weeks.[17] Other studies have also reported that eye movement training is specific and non-transferable in saccades[18] and pursuits.[19]

In this context it is important to consider the effects of repeated testing on these functions. Two studies reported no change in saccadic variables after repeat testing.[20, 21] In contrast, Schalen[22] found a significant difference in maximum velocity smooth pursuit gain and the amplitude of smooth pursuit.

In summary, some studies on the effect of eye movement training are in the context of improving function in the presence of an ocular motor disorder, either aimed at improving the rate of recovery of systems known to usually improve spontaneously; or at improving function in chronic conditions.[1-6] Other studies trained ocular motor function in the presence of normal eye movements, usually in an attempt to gain superior function. In one study, there was an improvement in parameters that were decreased, but no change in those functions approaching full adult function.[5] It appears that any improvement is training specific, with no transfer between ocular functions.[1, 6, 15, 18, 19] This raises the question that training in the presence of normal function may have a 'ceiling effect' where the performance is increased only to the level of optimal normal function, possibly reflecting an increase in awareness rather than an actual change in neurological processes. This level needs to be established prior to evaluating the effects of eye exercise programs on patients with eye movement disorders.

It is well accepted that there are changes in eye movement function with aging and it appears that the decrease in function may be related to increased target amplitude in saccades and increased target velocity in smooth pursuit movements.[20, 23-26] Therefore aging changes may only become apparent in the stressed situation, when the task requires optimal neurological functioning, but tasks within the range performed in normal daily viewing may show no decrement.[27] This study of the effect of training aimed to establish whether any change in the responses could be gained by eye movement practice in both a young and an older adult group. The saccadic amplitude and smooth pursuit velocity chosen for training were values greater than those performed in everyday viewing in order to ensure that the training performed was beyond the range of normal eye movement functioning. The aim was to demonstrate whether there is a 'ceiling effect' on performance, whether the eye movement changes associated with aging are reversible and whether there was a differential training effect for age.

METHOD

Participants

From an initial group of 181 participants in a study of the effects of aging,[27] a number were recruited to participate in this second study. There were three groups, two were assigned to practise eye movement exercises and another acted as a control group. One group of 28 participants (7 males and 21 females, 17 to 31 years, mean age 19.2, SD 3.12) was from the young adult group, another 34 participants (9 males and 25 females, 60 to 78 years, mean age 68.1, SD 4.17) were from the older adult group. There were 36 participants in a control group, selected from across the full age range (15 males and 21 females, 26 to 77 years, mean age 47.2, SD 14.39). Selection of those requested to participate in the training and control groups was by systematic sampling prior to the measurements of their initial ocular motor function.

The study was approved by the Faculty Human Ethics Committee, La Trobe University.

Instrumentation

Eye movements, saccades and smooth pursuit, were recorded using the Ober2 infrared reflection binocular measurement system, as reported in the previous study.[27]

Procedure

After gaining informed consent, the initial eye movement recording was completed. Measurements were made of saccadic latency, duration, mean and standard deviation of amplitude, and peak velocity of 10, 20 and 30 degree saccades; pursuit gain, pursuit time (percentage of recorded cycle that was defined as smooth pursuit), frequency and amplitude of catch-up saccades of 6.5, 12.0, 19.4, 25.9 and 38.6 degrees/second pursuit targets.

After completing the recording, the eye movement exercises were demonstrated to each of the participants recruited into the training groups. After this training session they were each given an exercise card, an exercise recording sheet and a return appointment. The exercise card was designed to practise saccades of 30 degrees amplitude and pursuit movements of 30 degrees/second velocity.

Two targets, **R** and **L**, were printed on a manila card, with a length of string attached as a distance marker. The participants were to be seated in a comfortable position with the card in front of them. They were instructed to practise saccades, looking alternately from the target **L** to the target **R** at the rate of one target per second for 20 movements (10 cycles) without any head movement. This was followed by a set of pursuit movements, practised by holding a pen in one hand against the exercise sheet and moving it smoothly from left to right and return at the rate of one movement per second, following the pen with the eyes as closely as possible for 20 movements (10 cycles). These two exercises took a total of 40 seconds of practice, followed by a 20 second period of rest. This set was repeated twice more, involving a total of 3 minutes. This training session was repeated 3 times daily for 2 weeks, allowing for the maximal training effect as proposed by McHugh and Bahill[19] in the time period suggested by Fischer and Ramsperger.[15] The time of each session was noted on the recording sheet.

On retesting approximately two weeks later, the completed exercise schedules were returned and they were asked to demonstrate the exercises as they had been practising them. The eye movement recordings were then repeated. Those who were assigned to the control group received no further instructions and were given an appointment to return for a repeat test in two weeks time.

Analysis

As the aim of this study was to investigate whether there was a different training response between the three groups, the saccade and smooth pursuit dependent variables were converted to change scores to allow a two-way ANOVA. The measurement of the first test was subtracted from that of the second test to obtain the change score.

In the study of saccadic function the two independent variables being investigated were group (three levels, young training, older training and control) and target amplitude (three levels of target amplitude, 10, 20 and 30 degrees). In the study of pursuit function the two independent variables being investigated were group (three levels, young training, older training and control) and target velocity (five levels of target velocity, 6.5, 13.0, 19.4, 25.9 and 38.6 degrees/second). For the analysis of saccades each of the dependent variable change scores was analysed using a two-way Group by Target Amplitude ANOVA and for smooth pursuit each of the dependent variables was analysed using a two-way Group by Target Velocity ANOVA. Rejection of statistical null hypotheses was set at £ 0.05.

The criteria was set as previously that only data from participants where there were at least six acceptable recordings within each set of ten samples was analysed.[27] For saccadic function the final number of participants from which the data for all variables was analysed was 18 in the young training group, 31 in the older training group and 31 in the control group. For smooth pursuit function this was from 27, 21 and 27 participants respectively.

RESULTS

The time between the first and the second test ranged from 13 to 26 days with a mean time of 14.4 (SD 2.33) days in the young group, 12 to 28 days with a mean time of 14.9 (SD 2.82) days in the older group and 12 to 35 days with a mean time of 16.8 (SD 4.8) days in the control group. The number of eye movement exercise sessions in each of the training groups were as follows; between 24 and 40 with a mean of 34.5 (SD 4.90) in the young group and between 31 and 48 with a mean of 39.3 (SD 3.87) in the older group.

Saccades

Latency

It can be seen in Figure 1, the latency scores pre- and post-training, that the mean latency was different for each of the groups at all target amplitudes, confirming the aging effect of saccadic latency reported previously,27 with the older group having the longest latency. Analysis of the change scores found no training effects for saccadic latency [F (2, 77) = 0.03, p = 0.9689], with no significant difference in the change in mean latency between the three groups. There was no consistent target amplitude effect on the change scores [F (2, 154) = 1.03, p = 0.3588]. Though the three groups each showed different directions of latency changes, there were no significant interaction effects [F (4,154) = 2.34, p = 0.0573].

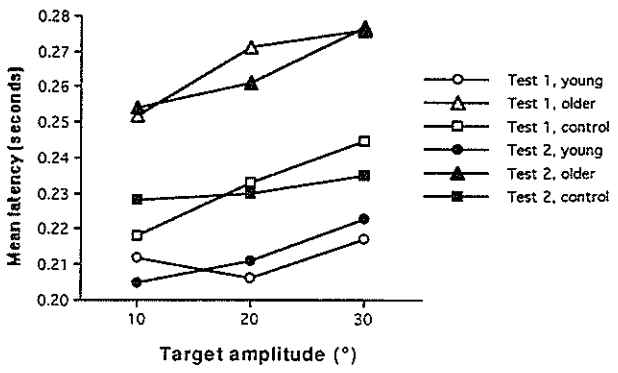

Figure 1 Mean latency scores on Test 1 and Test 2 for the three groups at each target amplitude

Duration

It was previously reported that there was a small but significant increase in duration with age.[27] Figure 2 presents the mean saccadic duration of each group pre- and post-training. Analysis of the change scores found no overall training effect [F (2,77) = 1.83, p = 0.1673], nor any consistent target amplitude effect [F (2, 154) = 2.83, p = 0.0622]. However, a significant interaction effect was found in the mean duration change scores [F (4,154) = 3.16, p = 0.0157]. The older training group remained essentially stable from the first to the second test at all target amplitudes, with mean duration of 64 and 87 milliseconds (msecs) for 20 and 30 degree saccades respectively, changing by only 0.13 and 0.32 msecs. However, both the young training group and the control group showed an increase in duration in the order of 2 to 4 milliseconds for 20 and 30 degree saccades.

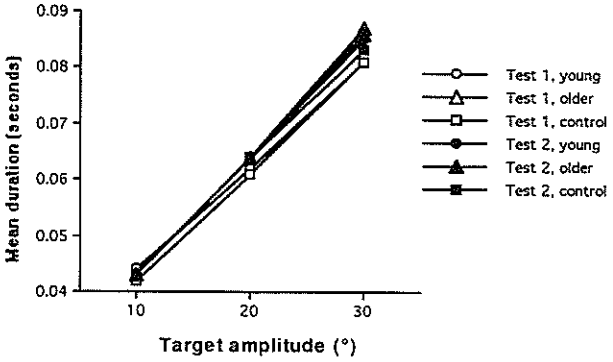

Figure 2 Mean duration scores on Test 1 and Test 2 for the three groups at each target amplitude

Amplitude

Figures 3 and 4 present the mean and the standard deviation of saccadic amplitude pre- and post-training respectively. The decrease in saccadic accuracy with age is seen in Figure 4, as individual variance increases with age, as previously reported.[27] There were no significant differences in the mean saccadic amplitude change scores [F (2, 77) = 0.25, p = 0.7761] or in the individual standard deviation change scores [F (2, 77) = 0.49, p = 0.6171] between the three groups, indicating no training effects for mean saccadic amplitude or saccadic accuracy as measured by individual variance. A significant target amplitude effect was found [F (2, 154) = 5.76, p = 0.0039], but as saccadic amplitude was the measured variable, the difference between the two test results was expected to be larger as amplitude increased and was therefore of no interest. Though the three groups demonstrated some differences in saccadic amplitude change at different target amplitudes, there were no interaction effects for either mean saccadic amplitude [F (4, 154) = 1.15, p = 0.3353] or standard deviation of saccadic amplitude [F (4,154) = 0.19, p = 0.9438] further confirming the lack of training effect on saccadic accuracy.

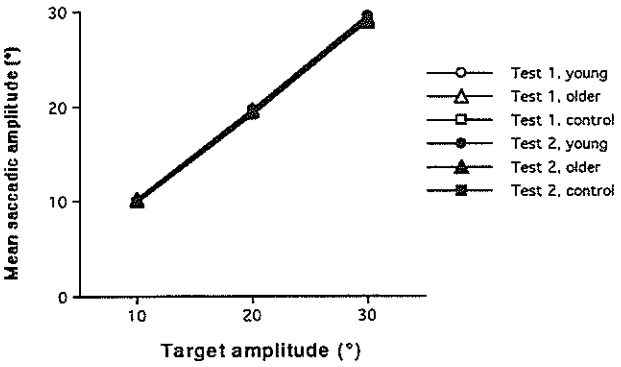

Figure 3 Mean saccadic amplitude scores on Test 1 and Test 2 for the three groups at each target amplitude

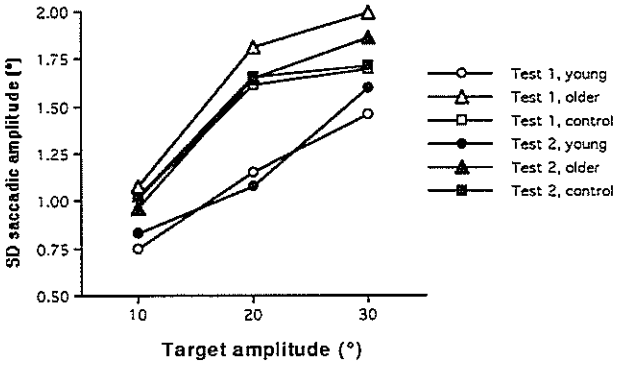

Figure 4 Mean standard deviation of saccadic amplitude scores on Test 1 and Test 2 for the three groups at each target amplitude

Peak velocity

It can be seen in Figure 5, the peak velocity scores pre- and post-training, that there was a decrease in mean peak velocity from the first to the second test for both the young and the control groups, particularly for 20 and 30 degree saccades, but very little change in peak velocity for the older subjects. Analysis of the change scores found a significant training effect for mean peak velocity [F (2, 77) = 3.49, p = 0.0356]. The mean peak velocity change scores for both the young and the control groups increased with increasing target amplitude, but this was not found to be a significant target amplitude effect [F (2, 154 = 2.20, p = 0.1141]. There was no significant interaction effect [F (4, 154) = 0.84, p = 0.5009]. The mean peak velocity decreased post-training for the young group, from 554 to 528 degrees/second for 20 degree saccades and from 747 to 678 degrees/second for 30 degree saccades; in the control group the values decreased from 536 to 505 and from 686 to 645 in 20 and 30 degree saccades respectively. Whereas the older group increased from 490 to 513 degrees/second in 20 degree saccades and remained stable at 638 for 30 degree saccades.

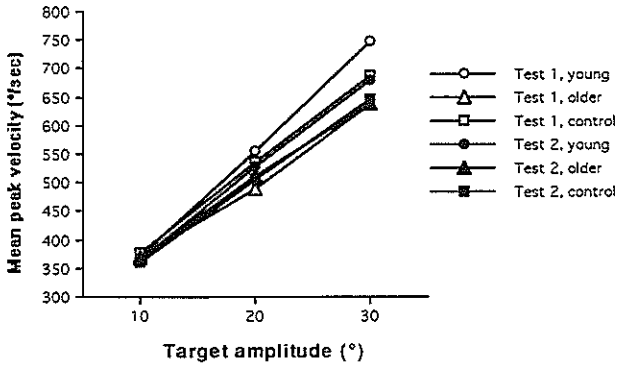

Figure 5 Mean peak velocity scores on Test 1 and Test 2 for the three groups at each target amplitude

Smooth pursuit

Pursuit gain

It can be seen in Figure 6 that the gain values were less in the older group than the young group as reported in the previous study.27 Regardless of the initial level of pursuit gain, a significant training effect was demonstrated by an increased mean pursuit gain post-training at all target velocities for both the young and the older training groups, and a decreased mean gain for the control group [F (2, 72) = 6.24, p = 0.0032]. The gain increase was larger in the older than the young training group at all but the two slowest velocities. The greatest difference in pursuit gain increase was seen at 19.4 degrees/second target velocity, with the young group increasing from 0.86 to 0.88 and the older group from 0.71 to 0.79. At 25.9 degrees/second velocity the young group increased from 0.80 to 0.82 and the older group from 0.61 to 0.66, and at 38.6 degrees/second the young group increased pursuit gain by 0.036 while the older group increased by 0.074. Pursuit gain decreased minimally at all target velocities in the control group, with the amount varying from 0.001 to 0.048 at different velocities. There were no significant target velocity [F (4, 288) = 0.56, p = 0.6886] or interaction [F (8, 288) = 1.66, p = 0.107] effects for pursuit gain change scores

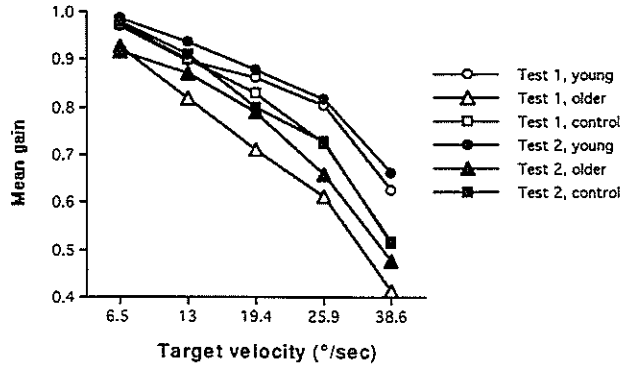

Figure 6 Mean gain scores on Test 1 and Test 2 for the three groups at each target velocity

Pursuit time

Similar to the findings of pursuit gain, an aging effect can be seen for mean pursuit time, with the young group demonstrating a higher percentage of time than the control and the older groups, as previously reported.[27] It can be seen in Figure 7 that mean pursuit time was increased post-training in both the older and the young group with the control group

changing only minimally, demonstrating a significant training effect [F (2,72) = 10.99, p = 0.0001]. For both training groups the pursuit time change scores showed a greater increase post-training as the target velocity increased, with a significant target velocity effect [F (4, 288) = 12.20, p = 0.0001]. The older group improved more than the young group, but the control group varied from a minimal increase to decrease as target velocity changed, demonstrating a significant interaction effect [F (8, 288) = 4.36, p = 0.0001]. For example the mean percentage increased from 95.9% to 96.6% in the younger group and from 93.2% to 95.2% in the older group at the target velocity of 19.4 degrees/second, and from 85.6% to 87.5% in the younger group and from 80.8% to 84.9% in the older group at 38.6 degrees/second.

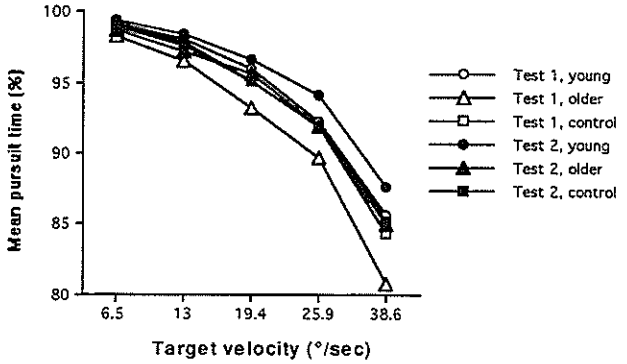

Figure 7 Mean pursuit time scores on Test 1 and Test 2 for the three groups at each target velocity

Saccadic frequency

Concurrently with the increase in pursuit gain, a significant training effect was demonstrated as a decrease in the frequency of catch-up saccades post-training during pursuit movements at all target velocities [F (2, 72) = 3.63, p = 0.0315] as demonstrated in Figure 8, the saccadic frequency scores pre- and post-training. The older group demonstrated a greater improvement than the young group. The high saccadic frequency found in the older adult group pre-training, particularly at the slow target velocity of 6.5 degrees/second, was reduced, which may reflect a decrease in distractibility. There was a small decrease in the saccadic frequency recorded at the second test by the control group at the two slowest target velocities, but at all other velocities the frequency was minimally increased. As previously reported, there was a difference in saccadic frequency between the young and older groups at all velocities, though minimal at the fastest target velocity of 38.6 degrees/second.[27] There were no significant target velocity [F (4, 288) = 2.11, p = 0.0799] or interaction [F (8, 288) = 0.73, p = 0.663] effects.

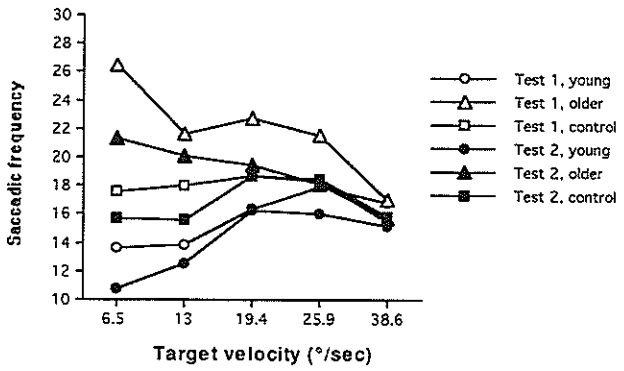

Figure 8 Mean saccadic frequency scores on Test 1 and Test 2 for the three groups at each target velocity

Saccadic amplitude

A significant training effect was demonstrated at all target velocities with a decrease in the mean saccadic amplitude of catch-up saccades, slightly greater in the older than the young training group, with no real change in the control group [F (2, 72) = 3.24, p = 0.045] as can be seen in Figure 9. The significant increase in saccadic amplitude change scores with target velocity is due to the effect of the increasing size of catch-up saccades as target velocity increased [F (4, 288) = 4.31, p = 0.0021]. As previously reported, the older training group demonstrated significantly larger catch-up saccades than the young group.[27] There was no significant interaction effect [F (8, 288) = 1.66, p = 0.107].

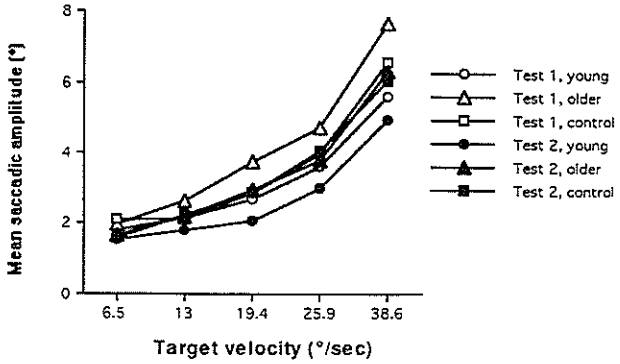

Figure 9 Mean saccadic amplitude scores on Test 1 and Test 2 for the three groups at each target velocity

DISCUSSION

The results of this present study have found some interesting effects on saccadic function after eye movement training. There were no differences between the three groups in the change scores of saccadic latency and accuracy post-training. In contrast, saccadic duration increased and peak velocity decreased in both the young group after training and the control group on the second test, whereas in the older group after training both of these variables remained essentially stable.

Previous studies have reported minimal training effects on saccades in the presence of normal ocular motor function. The finding of no change in peak saccadic velocity after eye movement training, as demonstrated by the older training group, agrees with that of other studies.[5,12] One study with only three subjects reported a decrease in peak velocity similar to the young and control groups over two test sessions.[28] Two

studies reported no significant differences on test-retest of peak saccadic velocity,[20, 21] a finding not supported by the present study. Gauthier and Hofferer5 reported an increase in saccadic accuracy in a group of normal children.

In comparison, training effects have been demonstrated in both children with ocular motor disorders due to chronic neurological conditions and in adults with acute neurological conditions with an expectation of recovery. Two studies reported post-training improvement in saccadic function in children with cerebral palsy.[4, 5] One reported increased latency and accuracy, but no change in peak velocity,[5] the other graded improvement on observation only, so no detail was available.[4] In adults with ocular motor palsy, improvements in saccadic gain have been reported post-training,[1, 2] but with no change in peak velocity.[2]

The present study has shown training effects on all variables of smooth pursuit function, demonstrated by increased mean pursuit gain and increased percentage of pursuit time, with decreased saccadic frequency and amplitude. The older group improved by a greater amount than the young group, with the control group showing a minimal decrease in function for most of the measured variables.

Previous studies which have trained pursuit function in the absence of any ocular motor disorder have reported improvements in adults[14, 19] and children.[5] Larsby et al[24] described reduced pursuit gain in a group of young children, in comparison to the expected adult level, and suggested that inattention and lack of motivation may be the cause of this reduction. This may be confirmed by adult studies demonstrating improved pursuit with alerting to the task[29] or when a detailed target was used.[30]

As in saccadic function, smooth pursuit has been shown to improve in the presence of ocular motor disorders. Two studies reported improvement in pursuit function in children with cerebral palsy,[4, 5] though it was noted that these children still did not improve to the level found in a healthy group.[5] Two studies reported increased pursuit gain and decreased recovery time in patients with pursuit disorders following neurological damage.[1, 3]

Various studies have suggested that ocular motor training is specific to the task required, some in the context of elite athletes having superior visual skills, but only within the requirements of the particular task,[13] others questioning whether training a particular task component has any effect on the complex perceptual motor task,[8, 9] others more specifically stating that learning is individual to each training task.[1, 6, 15, 18, 19] This would suggest that there is no transfer between functions served by separate neural pathways.

It has been suggested that the training improvements in the presence of ocular motor disorders may be due to changes in central nervous system programming and processing, rather than brainstem areas, as saccadic velocity remains unchanged.[2, 5] In children with cerebral palsy it might be suggested that as well as having neurological pathology, they may not gain the usual level of maximal visual stimulation due to the constraints placed on them by their general motor disorder and so ocular motor training may in some way provide this. For those changes effected in children with no known neurological or ocular motor disorder it was apparent that they had not yet achieved full ocular motor function and that possibly training either provided increased stimulation to assist normal development or more likely raised the level of attention.

The decreased saccadic function associated with aging demonstrated by increased latency, increased duration and decreased accuracy, are all thought to be due to degeneration of central nervous system areas such as the cerebral cortex and cerebellum. It appears that these changes are not readily amenable to training in older adults in the way they may be in children, where the process may be to achieve optimal functioning of a not yet completely functioning system, whereas in older adults there are irreversible changes causing the decrement in function.

In the present study the decreased smooth pursuit function associated with aging was demonstrated by decreased pursuit gain and decreased pursuit time, compensated by increased saccadic frequency and amplitude. Each of these changes was improved by training, both by the young and the older adults, with a minimal decrease in function demonstrated by the control group. The older training group showed greater improvement in each of these functions than the young training group, but a 'ceiling effect' was evident in that even though the training effect was greater, the pursuit function of the older group was not improved to the level of the young adults.

The role of visual awareness must be considered in any study of eye movement function. Studies have shown improvement in eye movement performance in relation to attention.[7, 14, 19, 29, 30] The eye movement responses at the second testing in the control group showed a decrease in function in several of the variables of saccade and smooth pursuit function. The decreased function demonstrated by the control group may be considered to be related to reduced motivation or visual attention on repeated testing. It is interesting that this result of decreased function was also shown by the young training group for saccadic eye movements. This presents the contrast where the pursuit system improved post-training in the group of young adults, but the saccadic system showed a decrease in some variables of measurement.

The differential improvement between saccade and pursuit function may be due to the fact that smooth pursuit eye movements, where the head and body are stable and only eye movement occurs, are not practised in normal everyday viewing. This would link with the hypothesis suggested by Enderle12 that eye movement performance is optimised naturally for all people by practise in normal viewing conditions. So where saccades are maximally stimulated at all times in normal viewing conditions, pursuit training may have resulted in an improvement in function as a result of stimulation that was above the level of that provided during normal viewing. This would be supported by the improvement in pursuit function demonstrated by both training groups in the absence of an improvement in saccade function and in fact, in the presence of a decrease in saccadic function in the young group. Also the greater training effect shown by the older group may be interpreted as an age-related decline in function of an under-stimulated system which could be improved by stimulation, but that this occurs concurrently with an actual decrement of the central nervous system.

CONCLUSION

In the present study saccadic function showed no improvement post-training in either the young or the older adults, whereas smooth pursuit function demonstrated improvement in both groups. This finding suggests that the age-related decline in ocular motor function due to cerebral cortex and cerebellar degeneration, increased neural conduction time and extraocular muscle changes is not reversible by exercise, but that some improvement in pursuit movement can be gained by maximally stimulating the pursuit system and by increasing the subject's awareness of eye movement functioning. It is important to consider this finding of relative improvement in smooth pursuit function, as any measured improvement with eye movement training must be considered against this baseline level.

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Double Trouble: Patient Satisfaction Following Non-surgical Intervention for Diplopia

Authors:
Ann Macfarlane, DOBA
Karen Pedamont, Dip ApSc(Orth) DOBA

Address for Communication:
Bankstown/Lidcombe Hospital
Eldridge Rd Bankstown, 2200 NSW
AUSTRALIA

ABSTRACT

Background: A review of 24 consecutive referred patients, presenting with diplopia was conducted to determine whether the patient found Orthoptic intervention to be beneficial.

Method: The severity and frequency of the diplopia was evaluated by the patient pre and post intervention using a modified Likert scale. The Orthoptic intervention included either Fresnel prisms, occlusion, or use of a head posture.

Results: Post intervention, a high percentage (83%) reported no diplopia and improved satisfaction.

Conclusion: Diplopia intervention is beneficial and results in a high level of patient satisfaction.

Key words: Diplopia, Orthoptic intervention, patient satisfaction

INTRODUCTION

Diplopia is a frequent symptom referred to our Orthoptic team for intervention. Unlike young children, adults are less likely to suppress the diplopic image therefore effecting activities of daily living, such as reading or driving a car. [1] Patients may be self conscious about their ocular alignment, also reporting nausea and dizziness.[1] Current research reports that poor vision including impaired depth perception is strongly linked with falls in older Australians.[2]

The role of the Orthoptist in cases of diplopia is to assess the extent and variation of the condition and provide non- surgical intervention. This can relieve symptoms, improve comfort, restore confidence and assist patients in returning safely to daily activities.[3,4]

The aim of this project was to determine whether the methods of diplopia intervention currently used by our Orthoptic department resulted in patient satisfaction. Our project was conducted, as an Orthoptic Department Quality Improvement project approved by the Division of Community Health and Allied Health, Bankstown Health Service 2003.

Successful diplopia intervention requires an accurate history. Binocular diplopia must be established, along with its type, frequency and severity.[5,11] It is also important to establish the onset of the diplopia, as generally 6 months is the minimum time to wait for any possible recovery before surgical intervention. [3,11]

The main aim of intervention is to help the patient regain fusion or make them comfortably monocular.[4] When possible restoring binocular single vision is essential for patient comfort and it is also best practice.[3,4]

The non-surgical interventions for diplopia used in this study, included Fresnel prisms, partial or complete occlusion or the use of a head posture.

The primary aim of prism therapy is to join the two images, and reduce the power of the prism when and if the diplopia resolves. Fresnel prisms restore binocular single vision, are temporary, durable, flexible, re-useable and light –weight. Ease of application and the fact that they can be used in sections[4], i.e. cut and fitted to upper or lower areas of the spectacle lens makes fusion achievable in various positions of gaze.[6,7] They are also inexpensive compared to the purchase of spectacles. Prisms are very successful in managing both horizontal and vertical diplopia caused by ocular nerve palsies[8], or as a complication of eye surgery eg cataract surgery.[9] The disadvantages of Fresnel prisms include the cosmetic appearance, blurred vision, and decreased contrast. Patients may also complain that the prism causes the effect of looking through a Venetian blind. [4]

In cases where prisms are not successful, occlusion or a head posture can be used. Occlusion will eliminate one of the two images. This will result in the patient being monocular with the disadvantage of having a decreased visual field as well. Partial occlusion can eliminate diplopia in a certain direction of gaze, with the associated advantage of allowing the patient to be binocular in the remainder of their visual field.[10]

A head posture may be naturally adopted by a patient by turning the face to one side, tilting the head, or raising the chin. This places their eyes in a position where the diplopia is not present.[1] The Orthoptist can also teach the patient how to position their head in one or any combination of these positions.

Current literature often suggests that the above methods of intervention be trialled and mentions the likelihood of success in certain cases[9,10] however there appears to be little detailed information available about a patient's perception of the success of intervention or reference to alleviation of patient symptoms. This study provides information in this area.

METHODS

Participants

The files of 24 consecutive patients who were referred to the service for diplopia intervention were reviewed. All participants regardless of age or gender were included in the study. Patients included in-patients and out patients.

Instrumentation

The impact of the diplopia intervention was reviewed. A modified Likert scale was used to determine the severity of the diplopia prior to and following intervention. Zero being not severe and 10 being most severe. The frequency of their diplopia was also scaled from zero to ten. Zero being never present and 10 being always present.

Procedure

All patients had a neurological condition which required a full Orthoptic assessment and the impact of the intervention was documented. The Orthoptic assessment included: (a) A detailed history and analysis of symptoms especially diplopia (onset, type, direction of gaze, severity, and frequency). (b) Visual acuity at 6m and 1/3m. (c) A Cover test at 6m and 1/3m. (d) An Ocular motility assessment including a diplopia chart or Hess chart.

(e) A visual field test. (f) An assessment of visual neglect.

Prior to diplopia intervention the patients were asked to scale the severity and frequency of their diplopia from zero to ten. Immediately following the intervention the patients were asked to scale the severity and frequency again. For the purpose of this study a health outcome (Gold standard) was set. If the severity and the frequency both rated zero post intervention, then the health outcome had been achieved. In cases where the health outcome was not achieved, details of the post intervention symptoms were recorded. The type of intervention used was based on clinical judgment, Fresnel prisms, being the preferred option.

To establish which Fresnel prism would be used, the angle of the deviation was measured using a prism bar. The minimum correction which provided the patient with comfortable single vision was also established.[11] Then by using a Fresnel prism the power was confirmed by the patient. The patient was also asked to choose which eye they preferred to have the prism placed over. This is vital for patient satisfaction as not all patients prefer the non dominant eye, or the eye with the weaker vision. If the Fresnel prism was only required for near or distance then it would be cut to size before attaching it to the appropriate section of the patient's spectacle lens. If the patient had vertical and horizontal diplopia, an oblique prism was used to allow correction of both with a single Fresnel prism.[11]

Analysis

The results were analysed using descriptive statistics as well as qualitative information.

RESULTS

There were 8 male and 16 female subjects, aged between 28yrs and 93yrs with a mean age of 65yrs. All patients had binocular diplopia, 22 of recent onset and 2 resulting from decompensating strabismus. Table 1 shows that the majority of the patients, 19, had an ocular cranial nerve palsy. These were distributed fairly evenly between the three ocular cranial nerves. One patient presented with an internuclear ophthalmoplegia and one with a convergence failure. Two patients presented with a decompensated strabismus.

Table 1: Aetiology of Diplopia n=24

Aetiology of diplopia	n=24
III Nerve Palsy	5
IV Nerve palsy	6
VI Nerve Palsy	8
Internuclear Ophthalmoplegia (INO)	2
Convergence failure	1
Decompensating Strabismus	2

Table 2: Summary of Treatment Methods

Method	Patient number (N = 24)	
Prisms	On whole lens	11
	On part of lens	6
Occlusion	Totally occluded	5
	Partially occluded	1
Abnormal Head Posture		1

Table 2 presents a summary of the treatment methods used to eliminate the diplopia. Following intervention 20 out of 24 patients had no diplopia. 17 cases were managed with Fresnel prisms, 11 of these cases required a prism over the whole lens, one of which was tilted at 45 degrees to successfully neutralise vertical and horizontal diplopia caused by a Fourth Nerve Palsy. 5 cases required a prism for distance only and one case required a prism on a bifocal segment, as diplopia was only present while reading.

Occlusion was used in 6 cases where either the angle size was too large for prism neutralisation (3 cases) or the angle was variable (1) or diplopia was directional

(2 cases). In one case partial occlusion was used to prevent diplopia in depression and right gaze only, (partial left Third Nerve Palsy) and allow the patient to remain binocular in the other positions of gaze. A head posture was taught for one case of a small angled, partial Third Nerve Palsy where fusion was achieved with a slight head tilt.

Table 3: Severity and Frequency Rating of Diplopia

Table 3: Patient Rating of Severity and Frequency of Diplopia

Rating	Intervention state	Mean	Range
Severity Rating 0 = not severe 10 = most severe	Pre intervention Post Intervention	8.35 0.4	2.5 -10 0 - 5
Frequency Rating	Pre intervention	8.29	5 -10
0 = never present	Post intervention	0.94	0 - 5
10 = always present			

The data in table 3 shows an overall reduction in the mean severity and frequency of diplopia following intervention. The patient's subjective opinion about the severity of the diplopia pre intervention ranged from minimal (2.5) to maximal (10). Post intervention most patients (20) reported the gold standard of no diplopia and therefore a zero ranking for severity. Similarly, the reported frequency of the diplopia pre intervention ranged from a mid range score (5) to severe (10). Post intervention the minimum response was 0 (20 patients) and the maximum response selected was 5 (4 patients). Of the four patients who reported diplopia post intervention, table 4 shows that the severity and frequency rating was considerably less than their pre-intervention rating.

Table 4: Details of Patients who experienced diplopia post intervention

	Patient	Patient A	Patient B	Patient C	Patient D
Residual diplopia		Intermittent	intermittent	Right gaze only	Right gaze only
Severity rating					
0 = not severe	Pre intervention	10	10	10	10
10 = most severe	Post intervention	2.5	5	0	0
Frequency rating					
0= never present	Pre intervention	10	10	10	5
10 = always present	Post intervention	2.5	5	5	5

DISCUSSION

The results of this study showed that most patients were successfully treated with prisms the remaining patients benefiting from occlusion or the use of a head posture. The 4 patients who still had diplopia post intervention decided to persist with the Fresnel prisms as this gave them the most satisfaction. As this study focused on satisfaction immediately following intervention, an area for further study would be to remeasure patient satisfaction months later as satisfaction may change. When using occlusion it's important to consider the use of partial occlusion so binocularity is maintained in other positions of gaze. Prisms should be considered firstly as they enable the patient to remain binocular. Although the literature reports several disadvantages of using Fresnel prisms the patients in this study did not report any. The fact that prism powers required by our patients did not exceed 15 prism dioptres most likely contributed to the patients not reporting a blur in visual acuity or decrease in contrast. In cases where prisms are not effective, occlusion or head posture should be trialled. Diplopia intervention is beneficial and results in a high level of patient satisfaction.

CONCLUSION

Diplopia intervention is an area of expertise for the Orthoptist. The desired result is single binocular vision or, if this is not possible, comfortable monocular viewing. Our results showed that most patients regain comfort through non-surgical orthoptic intervention.

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By Doing Eye Exercises Can you Really Throw Away your Myopic Correction?

Author:
Kathryn Thompson, DipApSc(Orth) DOBA
GradCertHealthScEd MAppSc(Orth)
Elaine Cornell MA Macq DipApSc Cumb PhD DOBA
Nathan Moss BSc(Hons) PhD

Address for Communication:
Kathryn Thompson, School of Applied Vision Sciences
Faculty of Health Sciences
University of Sydney
PO Box 170, Lidcombe NSW 2141
AUSTRALIA

ABSTRACT

Traditionally the correction of refractive error has primarily involved the use of spectacles, contact lenses or more recently refractive surgery. Vision therapists have proposed that visual blur caused by uncorrected refractive error, is a result of strain and stress by extra-ocular muscles and claim that ocular exercise regimes to alleviate such stresses are capable of altering adult refraction to the extent that no optical correction is required (Bates, 1920). However, there is little scientific evidence to support these claims.

Procedure

A study of 15 adults (18-53 years) who had myopic refractive errors were randomly assigned to one of two exercise regimes of similar duration (3 weeks). One treatment was based on the Bates method or Natural Vision Therapy (NVT) and the other used the Cam stimulator as a control therapy.

Results

While the subjects of this study were highly motivated to improve their visual function there were no statistically significant changes in refractive error with either form of treatment for spherical refractive error between NVT and Cam Stimulator treatments ($F(1,11) = 1.386, p = 0.264$). No significant main effects were found for spherical refractive error in either pre to post treatment ($F(1,11) = 0.438, p = 0.522$) or treatments ($F(1,11) = 0.035, p = 0.855$).

Discussion

A majority of participants reported perceived improvements in visual acuity and overall visual performance. However, objective measurements of visual acuity and eye muscle function revealed no significant alteration from baseline measurements. The reported improvement may be attributable to an increased tolerance of visual blur in some environments, and to the anticipation of improvement through ocular exercises as part of a belief that glasses were not remedial.

Key words: refractive error, vision therapists, Bates method

INTRODUCTION

Ametropia can be defined as an anomaly of the optical state of the eye where parallel light rays do not come to a focus on the retina specifically, the second principal focus of the eye does not fall on the retina when the eye is in a state of rest and subsequently results in blurred vision.[1,2] There are three main forms of ametropia. Hypermetropia or long sightedness is often described as an eye lacking in refractive power with the second principal focus behind the retina.[2] Myopia or short sightedness is described as a "powerful eye" where the second principal focus lies in front of the retina. Finally astigmatism is where the refractive system is such that no single focus of light on the retina occurs in an uncorrected state due to a non spherical surface, this primarily being the cornea. The causes of these refractive anomalies are multi-factorial with Genetics and environmental factors influencing the refractive status. Furthermore refractive status is not static by nature as it changes with age and developmental growth.[3]

As the prevalence of refractive error, particularly myopia is increasing [3,4] researchers are examining not only the causes of this irregularity but also available interventions to prevent its onset and progression. Interventions which have been trialed include optical methods such as under or over prescription of lens power[5], bio feedback training, [6] the use of bifocal[7] or varifocal glasses[8] and pharmacological cycloplegic agents[8]. Refractive correction with optical methods including glasses, contact lenses and refractive surgery can successfully correct refractive error, however these are not methods of preventing the disease or its progression.

Natural Vision Therapists or Vision Trainers claim that they have found success in the prevention and progression of refractive error using non optical methods including relaxation techniques and eye exercises. The origins of natural vision therapy (NVT) can be attributed to Dr.W.H Bates (1920)[9]. The Bates method was based on clinical observations that stress and strain on the extra ocular muscles appeared to cause a change in the shape of the eyeball and subsequently a change in the refractive state of the eye. The principles of the Bates method and its claims have yet to be empirically tested as there are very few scientific studies that have been conducted or reported in refereed journals. Farraway (1994)[10] studied a form of vision training derived from the Bates Method. This study did not reveal significant change in refractive status post treatment, however, it did highlight the need for further study and also identified the side effects of the treatment. In this study a high incidence of subjects self-reported adverse symptoms including headaches, pain and nausea. The dissemination of information pertaining to the practice and reported outcomes of vision training is primarily through self-publication and internet web sites.

The programs used by natural vision therapists are designed to modify the effects of environmental factors believed to impact on refractive status. They aim to relieve ocular stress and improve vascular circulation to the head and ocular structures. The treatment format encompasses at least some if not all of

the following practices: eye exercises, relaxation techniques, nutritional, spiritual and or mental guidance and spinal manipulation.[11-18]

In recent years, there has been a shift towards "natural" alternatives to traditional medical therapy. Studies of the use of alternative medicine have demonstrated significant increases in their provision and usage and an associated increase in expenditure. This shift is also evident with increased interest from the public and general medical practitioners[19,20]. Despite the international increase in the use of alternative medicine most alternative therapies have not been subjected to rigorous scientific evaluation [21].

While the outcomes of most alternative therapies have not been established the question remains as to why so many people are following the trend towards these remedies. Ernst and Herxheimer (1996)[22] suggested that patients who use both mainstream and alternative medicine report improved patient satisfaction with an alternative therapeutic encounter. Astin (1998)[23] investigated predictors for alternative medicine constructing a theoretical model to account for the increase in alternative health care use. The findings support a theory of "philosophical congruence" with individuals embracing health care that maintains a holistic or spiritual approach. MacLennan, Wilson and Taylor (1996)[24] profiled the Australian alternative medicine consumer as young, well-exercised, optimistic and residing in the country therefore not representing the chronically ill or disabled as predominant users.

Ernst et al[22] identified the need for research investigating placebo effects to distinguish benefits of mainstream and alternative practices. Recognition of any differences (likely non specific effects) with possible benefits are to be further studied, incorporated and subsequently optimised in mainstream medical practice.

It was the intention of this study to investigate whether any changes to: refractive error (quantified as a change in the dioptric power of the eye), visual acuity (quantified as a change in logMAR acuity) and factors which may affect ocular comfort (quantified as a change in accommodation and convergence values) occurred in participants who undertook a course of natural vision therapy (NVT) and a control treatment.

DESIGN

A within subjects' design was used with all subjects completing two treatments (Vision therapy and Cambridge stimulator [25]). Study protocol involved a daily home training schedule whilst without wearing refractive correction. An experimental period lasting eight weeks (six of active treatment) was conducted as existing literature (although often reporting instant improvement) suggests that this time should allow clear improvements to be witnessed [12]. To control for order effects, participants were randomly allocated into the two treatments treatment A was the NVT and treatment B was the Cambridge stimulator (CAM).

During the experimental period there were five observation periods where measurements were taken. To decrease any possible carry over effects of treatments, a one-week rest period where no treatment was conducted was given between each treatment period as follows:

Observation 1 = Pre measurements before commencing either treatment A or B

Observation 2 = End of treatment A or B after 3 weeks of continuous treatment

Observation 3 = Pre measurement before commencing either treatment A or B

Observation 4 = End of treatment A or B after 3 weeks continuous treatment

Observation 5 = Final measurements after completing both treatments and one week without any treatment.

Schematically this is represented below:

Key O = Observation X = continuous treatment

O1 XXX02 03 XXX04 05

SAMPLING

Subjects were recruited from within a University environment and were invited to participate in this study. All subjects were personally motivated to improve some aspect of their vision or lifestyle. Inclusion criteria were as follows: no previous history of vision training, a refractive error of any type and dioptric power corrected by either glasses or contact lenses, a willingness to participate in an eight week treatment program, be 18 years or over.

Fifteen participants took part in this study (three males and twelve females) aged between eighteen and fifty three years (mean = 31 years 2 months, SD= 14.1785). Twelve participants completed the entire treatment course within the treatment periods and the statistical analysis was based on these results. The three remaining participants completed one of the treatments and withdrew from the study citing work and life-related demands on time as their reasons for discontinuance. All of the participants naturally presented as having a myopic refractive error with or without associated astigmatism.

Pre treatment spherical refractive error ranged in strength from –0.75 DS to –13.75 DS with the mean spherical error being –3.71DS for all eyes. Pre treatment cylindrical error ranged in strength from +0.25 DC for all eyes with the mean cylindrical error + 0.76DC.

A calculation of an appropriate sample size to give relevant statistical power for this study was undertaken using the method described by Murphy and Myors (1998)31. Calculations indicated that for a sample where N = 15 it provides an F equivalent of 8.96 that extrapolates to a power of 79.4%, therefore it was planned to have a sample of 15 subjects. Even if the number of subjects was as low as N =10 this would still give power in excess of 0.8 with an effect size of 1. Given Bates' claims this is not unreasonable.

METHOD

Prior to commencing participants were asked a series of questions to establish present ocular comfort, present optical correction and satisfaction with this method of correction, as well as their motivation to participate in the current study.

At baseline and post treatment, measures of refractive error and keratometry readings were taken with the Humphrey Auto Refractor (Hark 599). Three measurements were taken of each eye and the mean was calculated for use in data processing. The corrected and uncorrected visual acuity of each subject

was assessed using a six metre direct LOGarithm of the Minimal Angle of Resolution chart (logMAR). The luminance over the chart was checked using a light meter (Sekonic Auto Lumi model L –158) and held constant within the range of 1300lx (standard room lighting). A subjective refraction was performed at the baseline and post treatment. The convergence near point (CNP) was quantified using the RAF rule or a millimetre ruler with the amplitude of accommodation being assessed with the RAF rule (binocularly and monocularly where applicable).

To control for extraneous variables a number of parameters were held constant during the testing environment, namely the examiner, instructions given and instruments used were the same for all measures. Where possible the appointment time for each participant's return visit was the same.

The natural vision treatment consisted of the following sets of daily exercises involving warm up (sunning), relaxation (palming), active exercise (swinging, shifting and visual memory, tromboning and the modified eye exerciser) and concluded with relaxation. Subject specificity was ensured with the NVT program tailored to meet individual needs such as the distance of the vision chart, eye exerciser and fixation targets. A daily exercise session was timed to take an average of twenty-five minutes (first 2-3 days of the first treatment week) decreasing to around fifteen minutes once participants were familiar with each exercise.

The Cam Stimulator was performed as a daily treatment session for a minimum duration of five minutes. For each of the treatment weeks a different size grating was used. There was no clinical reason for the use of the varied gratings in this study other than to show participants some degree of progression, prevent boredom and increase the face validity of the treatment.

For both treatments all participants were supplied with an exercise calendar to record their daily compliance and comments regarding symptoms (description, onset duration, location and severity of the symptoms and other associated signs ie nausea, neck stiffness and possible relief).

Analysis

With each subject receiving both treatments, measurements of refractive error were taken pre and post treatment. The measures of both spherical and cylindrical components were separately analysed with a repeated measures analysis of variance (ANOVA) using planned comparisons this controls for familywise type I error rates. As no treatments were directed at modifying the corneal shape and surface the axis of the cylinder was not analysed. Each eye was analysed as a

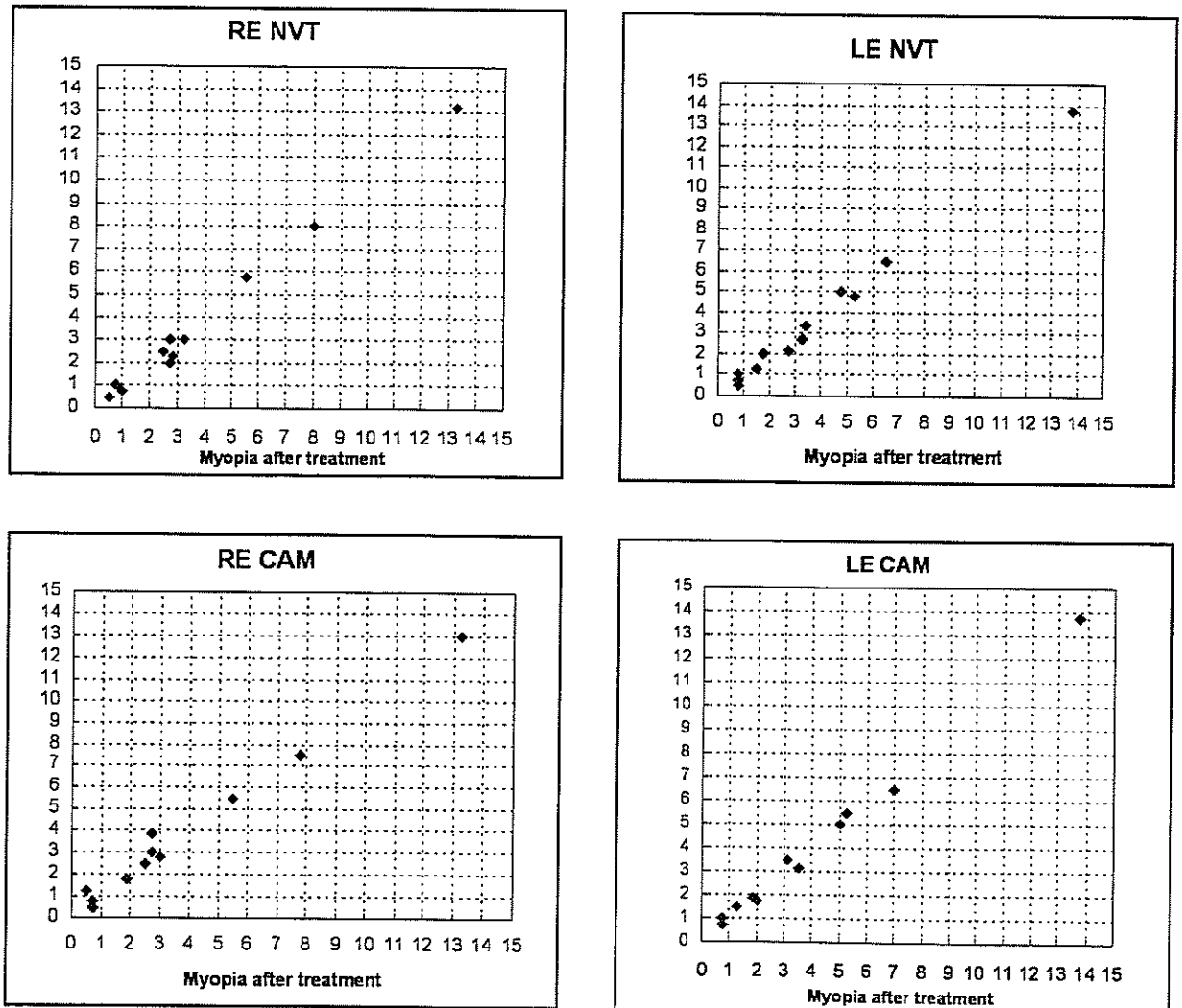

Figure 1 spherical myopic refractive error (DS) pre and post NVT and Cam stimulator treatment for both Right and Left eyes.

separate repeated measure in the analysis, therefore preserving the variance of both eyes (Newcombe & Duff, 1987).26

RESULTS

As noted in the methods section the individual motivations of participants to undertake treatment was addressed by interview. Table 1 lists the responses to this question. It is worth noting that some participants gave more than one reason.

Table 1 Participant motivations for treatment

Reason	Frequency of response
Go for periods without glasses and not feel the restriction of them.	2
Improve clarity of distant images.	1
Improve the health of the eye/s	1
Improve comfort and reduce symptoms of headaches.	3
Prevent the progression of myopia.	3
Go without glasses for social reasons whilst still maintaining clear vision	1
Tired of glasses and belief that there is minimal harm by participating	1
Problems wearing glasses for sport and exercise.	2

No significant interaction was found for spherical refractive error between NVT and Cam Stimulator treatments (F (1,11) = 1.386,p = 0.264). Similarly, no significant main effects were found for spherical refractive error in either pre to post treatment (F (1,11) = 0.438, p = 0.522) or treatments (F (1,11) = 0.035, p = 0.855). This can be further seen in Figure 1 where each participant's refractive error is plotted before and after treatment, with the diagonal line representing no change. Participants did not consistently vary from this line.

No significant interaction was found for cylindrical refractive error between NVT and Cam Stimulator treatments (F (1,11) < 0.001,p = 1.000). Similarly, no significant main effects were found for cylindrical refractive error in either pre to post treatment (F (1,11) = 0.319, p = 0.584) or treatments (F (1,11) = 0.330, p = 0.577). This can be further seen in Figure 2 where the diagonal line represents no change. Participants again did not consistently vary from this line.

As the focus of this study was to detect a change in refractive error, an analysis of many variables when the sample is small is undesirable. This type of analysis weakens the statistical power of the test and capitalises on chance to reveal a statistical difference. The results of the following variables are reported descriptively: pre and post treatment subjective refraction results, visual acuity; keratometry readings; accommodation; and convergence.

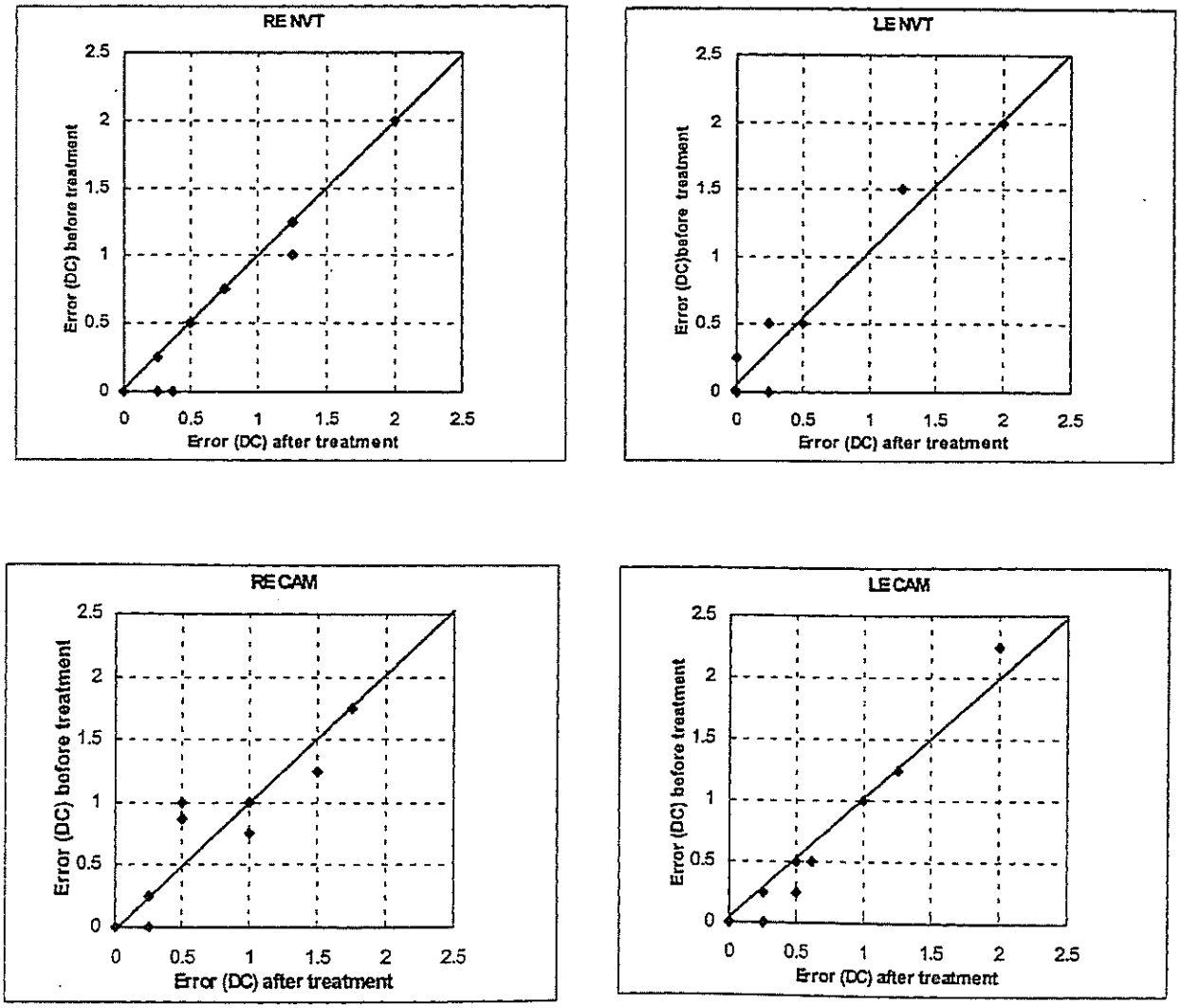

Figure 2 Cylindrical refractive error (DC) pre and post NVT and Cam Stimulator treatments for both Right and Left Eyes.

Table 2 shows the means and standard deviations of subjective refraction at observation one (pre treatment) and observation two (post treatment with either NVT or Cam Stimulator).

Table 2

Subjective refraction (Dioptres) Pre and Post NVT or Cam Stimulator treatments

	Right Eye M	SD	Left Eye M	SD	(n=12)
Pre	3.56	3.64	3.70	3.50	
Post	3.45	3.49	3.62	3.30	

Table 3 shows the means (M) and standard deviations (SD) for LogMAR visual acuity pre and post NVT and Cam Stimulator treatments respectively.

Table 3

Visual Acuity (log) Pre and Post NVT & Cam Stimulator treatments

Treatment		Right Eye M	SD	Left Eye M	(n =12) SD
NVT	Pre	.0583	.1165	.0416	.0793
	Post	.0500	.1168	.0583	.0900
Cam	Pre	.0416	.0793	.0583	.0900
	Post	.0416	.0793	.0583	.0900

The average automated keratometry readings were used for the calculation of the mean and standard deviation for both the right and left eyes pre and post both treatments. The right eye mean before (NVT) (Mean = 43.82 SD = 1.91) was very similar to post treatment (Mean = 43.83 SD = 1.86). Similarly the left eye mean did not change significantly pre NVT(Mean = 43.74 SD = 2.10) to post treatment(Mean = 43.71 SD = 2.03).

The right eye mean before Cam treatment was 43.68 (SD = 2.00) and post treatment was = 43.74 (SD = 2.04). No significant change was noted pre Cam treatment for the left eye (Mean = 43.80 SD = 2.12) to post treatment (Mean = 43.78 SD =2.12).

Tables 4 and 5 show the means and standard deviations for accommodative abilities with monocular and binocular results being presented pre and post NVT and Cam Stimulator treatments respectively.

Table 4

Accommodation Values (Dioptres) Pre and Post NVT

Eye/s		M	SD (n = 12)
Binocular	Pre	10.29	4.45
	Post	11.33	5.77
Right	Pre	9.08	4.58
	Post	10.79	6.24
Left	Pre	9.38	5.65
	Post	10.54	5.97

Table 5

Accommodation Values (Dioptres) Pre and Post Cam Stimulator

Eye/s		M	SD (n =12)
Binocular	Pre	11.63	5.75
	Post	10.79	4.77
Right	Pre	9.42	5.74
	Post	10.92	5.85
Left	Pre	8.75	6.04
	Post	10.50	6.03

Table 6 shows the means and standard deviations for convergence near point pre and post treatment for both NVT and Cam Stimulator treatments.

Table 6

Convergence (cm) Pre and Post NVT & Cam Stimulator treatments

Treatment		M	SD (n =12)
NVT	Pre	3.43	3.34
	Post	2.36	3.27
Cam	Pre	3.38	4.48
	Post	2.38	4.27

DISCUSSION

Various inferences can be drawn from the results of this study, however interpretation must take into account several factors; the sample size is small and the composition is only representative of an adult myopic population, therefore the findings of this study can only be related to this type of refractive error. Nevertheless, this sample's constitution is similar to that of the general population aged 18-53 years who wear glasses for distance vision Wu et al (1999)[27]. Even with a small sample there was a good cross section of refractive power studied, ranging from -0.50 DS to -13.50DS.

The results of this study clearly demonstrate that there was no evidence of a reduction in spherical or cylindrical refractive error following NVT and the placebo treatments, although NVT advocates that any size refractive error can be reduced. This finding corresponds with conventional clinical opinion and supports the belief that the dioptric amount of myopic refractive error cannot be reduced by treatments involving eye exercises and relaxation techniques. Figures 1&2 show participants individual refractive errors pre and post NVT and Cam Stimulator treatments respectively. It is evident that individual fluctuations did occur for some participants, this included changes in spherical error (either improving or worsening) usually ranging from 0.25DS to 0.50DS and in one case up to 0.75DS. For several cases no variation at all was recorded pre to post treatment. Overall, comparison of the sample pre to post treatments indicates the general ineffectiveness of NVT and the placebo Cam treatment on reduction of refractive error in adult myopic participants. These findings are consistent with Farraway (1994).

The lack of a noticeable reduction in physical factors causing refractive error is further supported by the measurement of corneal curvature, which did not reveal a significant change in mean curvature following either NVT or Cam Stimulator treatments. This lack of change in cylindrical error supports conventional opinion that exercises and relaxation techniques do not physically alter the anatomical structures or shape of the eyeball.

The role of perception of change and improvement in vision that may occur subjectively should be recognised. However, attributing them to change in refractive error cannot be substantiated by this study. Nevertheless, some participants did report feeling better. Better was described as seeing well, maintaining clear vision for periods without their glasses on, not experiencing symptoms of eyestrain. The reports of improved comfort and sight may well be the result of placebo

effect and possibly account for the success reported by NVT advocates; as stated by one subject "My sight is becoming clearer, I think". Another subject commented "I did not like the NVT as much as the Cam Stimulator. The Cam Stimulator treatment was more focussed and I felt the NVT was ineffective" and also "I did feel it work my eyes, sunning and palming were great relaxers and the tromboning exercise definitely made my vision clearer". Another participant's response was "I can now cope better at times without my glasses on and I feel more comfortable". Two participants voiced surprise that their visual acuity results did not reveal a measurable improvement and that the degree of their refractive error remained unchanged when they were convinced otherwise. Confirmation of participant satisfaction with vision post training was not measured in the current study. A Likert or similar scale asking participants to rank satisfaction pre and post treatment would be suitable if further study in this area was pursued. Angi et al (1996)[28] measured psychological distress pre and post biofeedback vision training using the self-rating symptom checklist (SCL 90). Results obtained indicated that all treated subjects reported a better quality of vision and satisfaction with vision training using biofeedback mechanisms. As with this current study, the reported satisfaction was unrelated to a change in refractive error.

A perceived subjective improvement in visual acuity could be attributed to an enhanced ability to tolerate and recognise blurred letters, as reported by Woods (1946)[29]. It seems possible that by purposeful training there may be an improved cortical ability to improve the interpretation of a blurred image and this may be achieved by NVT. Tolerance to blurred vision may also result from training for accommodative relaxation. This would be of assistance for accepting increased plus correction. If this is the case and its practice is not detrimental, then NVT advocates should acknowledge this component of training as an explanation for their supposed success.

It was hypothesised that improved accommodation and convergence recordings could result from undergoing the NVT training. As shown in the results, accommodation values did not appear to significantly change pre - post treatment. There was however, a slight trend towards improvement in accommodation values. Convergence near point also did not appear to vary greatly pre and post treatment. However, participants reported improved comfort when working in the near position.

During the treatment periods the participants in this study did not report unusual symptoms such as headache, nausea or retro- molar pain as noted in the Farraway study[10], however some did report tiredness for the first few sessions. The noticeable lack of unusual symptoms is attributed to the omission of head and neck rotations.

The possibility of adverse side effects generated by NVT is interesting in itself because it questions why NVT advocates continue to promote treatments in which participants can experience discomfort for little benefit?

In studies on the prevalence of myopia, researchers have studied associations between education, intelligence and income levels, reporting findings that the incidence of myopia is higher in college educated people.[27] The association between educational background and the incidence of myopia were not examined in this current study. However it would be reasonable to conclude that the sample used in this study is supportive of the above findings as the participants were university students, academic staff and professionals. Interestingly the sample used in this study also matched the profile of users of alternative medicine in an Australian population.

Consideration should be given to the sample in this current study, which was comprised predominantly of older subjects whose refractive error had stabilised. It is postulated that younger subjects (children) could be more suitable to vision training due to flexibility in accommodation and cortical plasticity. Birnhaum (1981) [30] states that in their experience it is very difficult to eliminate myopia which already exists, and that generally an aim of management is to stabilise or slow myopia progression.

Participant motivation is an essential pre requisite for any therapeutic effect.[28] One indicator which demonstrates a high level of participant motivation, is the good retention rate of this study, with only two out of the fifteen participants failing to return for follow up. Reasons cited for non-continuance stemmed from difficulties arising with regular performance of the treatments and regular attendance for measurements. These reasons are common problems and account for some of the drop out rates in treatment based studies and studies of long duration [28].

Repetition is an essential feature of exercise, training and learning. A daily compliance record of treatment supports the repetitive nature of training as well as monitoring participant motivation. An interpretation from the participants' recordings is that continuity of treatment occurred with daily repetition of the treatments and that the treatments were performed in the manner they were assigned. As the study's design was based on repeated measures, the participants had opportunities to regularly see the researcher. It is well recognised that the conduct of exercises under supervision is ideal to prevent repetition of flawed methods leading to faulty performance. Although participants in this study did not perform the treatments directly supervised by the researcher, it is believed that the regular contact between the researcher and participants further assisted compliance and participant accountability. It must be acknowledged that in a home treatment based study the final outcomes can be significantly influenced by poor or non- compliance. The analysis and interpretation of the results of this current study was necessarily based on the assumptions that the participants involved had performed both treatments and provided accurate information about their performance of these treatments.

Conclusions

In both this study and that of Farraway[10], NVT programs using similar treatment techniques and treatment periods of three and seven weeks respectively failed to show significant changes in refractive error, visual acuity and improved ocular comfort. Therefore, it appears that these treatments are inappropriate substitutes for mainstream practice. Whether there is any harm in practicing these alternative forms of treatment to complement the mainstream correction of refractive error remains to be seen. Although mainstream methods of correcting refractive error with glasses or contact lenses are not without problems, these methods are effective. It can be concluded that until further research provides evidence to enable a further understanding of the effectivity of NVT.

adherence to treatment methods which have been validated is strongly recommended.

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Child and Adolescent Health in Rural NSW

Authors:
Valerie Tosswill, Dip.App.sc., D.O.B.A

Address for Communication:
RFWCHS
Orthoptic Department
PO Box 52, Manly NSW 1655
AUSTRALIA

ABSTRACT

When looking at child and adolescent health in New South Wales (NSW), a significant number of problems and limitations become evident. The expectations placed on children today are becoming greater, with social and peer group pressures ever increasing. The health status and expectations of a child are closely linked to such factors as socio-economic and employment status, geographical location and education levels. An orthoptist is trained to assess the eye and ocular problems, however embracing family dynamics and looking at the larger picture assists in orthoptic outcomes. This paper highlights these issues, how they are being addressed by one organisation and how the orthoptist must acknowledge them for optimal results.

INTRODUCTION

Royal Far West Children's Health Scheme (RFWCHS/RFW) is a health facility in Sydney for rural NSW children and adolescents. With approximately 14% of the Australian population living in rural and remote areas[1,2], the average health status of children and adolescents from these areas is worse than that of those living in metropolitan areas, and it is often impossible to consider health in isolation from other social and economic factors[3]. The orthoptist is just one member of the health service provision team concerned with the child's general health and well-being.

The National Rural Health Alliance (NRHA) [3] – the peak body for rural and remote services for Australia – believes that health services should be guided by the following principles:

- the best interest for the child shall be the primary consideration
- the overall aim of the health care should be to protect and promote, to the maximum extent possible, the survival and optimal development of the child
- investing in the health of children with effective health promotion and early intervention programs that have been demonstrated to be cost-effective; and
- the team providing health care for children should ensure continuity, timeliness and quality of care.

These NRHA principles exist at RFW, where it is also believed that no child should be deprived of his or her right of access to health care services (Article 24 of the 1989 United Nations Convention on the Rights of the Child).

CURRENT ISSUES FACING CHILDREN AND ADOLESCENTS

Mental Health/Behaviour/Mortality

One in 5 Australians will suffer from a mental illness in their lifetime, and 14-18% of children and young adults experience mental health problems of clinical significance. Depression among adolescents is high and, furthermore, at least 62% of people with a mental illness are not accessing any kind of mental healthcare [4]. Anxiety is a problem that can affect people at all ages and is the most common emotional disorder in children and adolescents, affecting about one in ten.

In Australia in 2001, 1,931 children aged 0-14yrs died, representing 2% of all deaths. Of these, 1,290 were infants. Among children aged 1-14 yrs, injury and poisoning were the most common causes of death in 2000, responsible for 285 deaths 3. In 1996, 71% of all deaths at age 15-24 years were caused by injury, including traffic accidents, sporting accidents, peer group violence and self-harming behaviours [5]; second to injury as a cause of death was suicide [6]. A significant cause or contributor to adolescent morbidity and mortality has been identified as a lack of accessibility for young people to health services [5].

It has been estimated that one out of five women less than 25 years has been a victim of sexual abuse and this often begins in adolescence and goes unreported [6]. International and Australian studies [7] demonstrate that children experiencing disadvantage are more likely to have poor life outcomes in terms of physical and mental health, school achievement, employment and general life satisfaction. They are more likely to experience injury and to be objects of, and the perpetrators of, violence and criminal activity.

Behaviour problems in children are becoming more apparent and widespread. The Australian National Health Strategy Report (2000) [8] stated that ADHD was the most common developmental variation, affecting 1.2% of Australian children[9]. Though a number of children will 'grow out of it', 60% will carry some degree of ADHD with them into adulthood [10]. Children with ADHD have also been found to commonly have learning difficulties (25-50% of children), Oppositional Defiant Disorder (40-67%), Conduct Disorder (20-56%), Anxiety Disorders (25%) and major depression (0-30%) [11]. Additionally, Convergence Insufficiency (CI) has been reported as being co-morbid with ADHD [12].

Obesity

Childhood obesity is an epidemic in Australia. In 1995, the Australian Institute of Health and Welfare reported the proportion of overweight children and adolescents aged 17 was 21% for boys and 23% for girls [3]. In 2003, the issue of childhood obesity is still of concern, with obesity affecting one in five Australian teenagers [13].

Economic/Financial/Environment

Health problems of children and adolescents are exacerbated by income inequality and relative poverty, unstable family structures and deteriorating social capitol and social networks[3]. An increasing number of families cannot provide for their

children. The number of families living in poverty is no longer confined to those without work. Of the 2.5 million Australians who live in poverty, there are nearly 1 million working families who are not earning enough to lift them above the poverty line of $415 a week [4].

Literacy/education

In 1996, almost half of Australians aged 15-74 years had poor or very poor literacy skills[14]. There is an extricable link between health and education. Information sharing and the means of communication are also key determinants of health status. Good access to information and programs that promote early detection and intervention reduce the risk of poor health outcomes. Primary health care concepts can be very usefully integrated in the school curriculum and information dissemination can reduce the risk factors for adult chronic conditions such as hypertension, smoking, obesity and dental caries [3].

Australia spent over $66 billion on health in 2001-02, a rise of $11 billion since 1999-00 [15], yet the problems faced by children are still abundant. NSW Health recognises that allied health services are a critical part of the NSW Health Workforce [15]. However young people are generally low users of health services and consequently the ability of health professionals to positively influence health behaviour can be limited.

The NRHA [3] has stated that, for equivalent health and well-being, rural and remote communities need access to the same services as their city counterparts. To be effective, family services need to recognise the different types of family unity and to value their cultural differences. For effective family services in rural Australia as close to home as possible there needs to be

- an increase in the numbers of nurses, allied health professional and Aboriginal child health workers in rural and remote areas
- increased access to early intervention and health promotion programs for the early diagnosis of problems with hearing, vision, speech, ADHD, fine and gross motor development and dental care and hygiene, and
- more activities to strengthen family relationships, parenting skills and confidence.

Currently, there are a number of groups and organisations who are actively involved in rural and remote health care provision, including RFWCHS and Royal Far West School (RFWS).

ADDRESSING THE CURRENT ISSUES BY RFWCHS

Mental Health/Mortality/Behaviour/Family Relationships

It is important to identify children who are at risk of developing a mental disorder and /or attempting suicide eg those with a family history of mental illness, poor social skills, and/or those who are victims of bullying and abuse, neighbourhood violence, crime and peer rejection. RFW nursing staff conduct regular information sessions on depression to clients and offer counselling during the admission as well as follow-up post-discharge, especially for those children on medications. Referrals to local organisations are made if it is felt appropriate. RFW staff work in conjunction with DoCS/DADHC and various Disability Services.

The Social Work Department and the RFWS have developed the "Stop, Think, Do" Program so that the Scheme, School and the family are able to use the same social skills program throughout the child's admission and when the family returns home. Additionally, social workers offer ongoing counselling for all families whilst at RFW.

The RFW Recreation Team conduct activities that promote socialising skills and provide enjoyment for the children during their admission. The Occupational Therapy department addresses living skills including school skills, hand writing, dressing and the use of cutlery, thus creating a wholistic approach to the independence of the child.

To address the issues of mental health, behaviour and family relationships, a variety of programs have been developed - 'RAPteens' (for adolescents with adjustment difficulties which can lead to patterns of stress, anxiety and depression), 'Dolphin'(provides assessment and treatment for anxiety disorders in young people aged 7-16 years), 'ADDers' (for parents of children with ADD/ADHD with defiance or highly disruptive oppositional behaviour, aged 5-16 years) and 'Positive Parenting Program (PPP)' (aimed at families with children aged 2-8 years, who may be having parenting problems).

Obesity

Common causes of obesity are poor eating habits, lack of physical activity and family history. Nowadays, 'play' has been replaced by television, videos, computer games or the internet and children's diets have moved away from traditional eating habits. RFW addresses obesity in the following manor: the child's height and weight are monitored each admission; families with existing weight issues are regularly reviewed by the Dietician; exercise programs are tailored for individuals and the Catering Department maintains a healthy menu. A weight management and exercise group, 'WOW' (Weight Off Wisely), was developed a number of years ago. WOW is an interactive week-long program tailored to educate families about dietary modifications, the importance of exercise and behaviour changes in eating.

Literacy/Education

At the RFWS many of the students have significant learning difficulties, behavioural and emotional issues as well as a wide range of medical conditions and physical disabilities. The school provides a range of educational facilities, including literacy assessments, intensive reading support programs, parent education, referral to local educational services and a playgroup for preschoolers. There is an increasing emphasis on liaison with home schools and districts prior, during and after attendance at RFWS.

Cultural Awareness

RFWS has an Aboriginal liaison officer. There is also an Aboriginal policy and students to the school are invited to participate in all cultural activities.

HOW THE RFW ORTHOPTIST FITS INTO THIS MODEL

To make appropriate orthoptic management suggestions, all information regarding the child needs to be considered. If a family is struggling financially, consideration is given to the cost of glasses; if behaviour problems are a primary concern, glasses may be broken instantly or occlusion therapy patches removed and if the parents are unmotivated and the child has behaviour problems, home treatment for reduced convergence is unlikely to be carried out. When the family dynamics are such that the child is living in an unstable environment, expectations of any treatment being carried out will be lower. In cases where eye surgery is needed and hygiene is very poor, the child may be asked to stay on at RFW for longer post-operative care rather than returning home. If a child with very poor self-esteem, no ocular symptoms and good orthoptic standards wants glasses, they may be given plano glasses for a limited time to assist in improving self esteem and overall confidence. When confronted by an angry, depressed teenager with conduct disorder, who will not do their convergence exercises or wear their glasses, chastising will be of no help - a different approach is needed for the benefit of treatment to be understood.

Low literacy levels may make the assessment difficult if the child is unable to read a linear line or near text. Cultural awareness will ensure the most appropriate test and techniques are utilised. The orthoptist needs to be mindful that attention deficit (hyperactivity) disorder has a link to convergence insufficiency [12,16] and should therefore assess this binocular function more closely. Giving more praise than is necessary to a person with low self-esteem, or a teenager with poor family dynamics, may assist the orthoptist to gain maximal results. Extra encouragement to make a session more personalised gives consolidated quality time that the child might not gain from other areas of their life. Knowledge of a particular child who feels they cannot do anything well, may prompt the orthoptist to do a small yet significant act such as displaying the child's drawing on the clinic wall.

CONCLUSION

Feedback must be given to, and received from, all health disciplines, care-givers and teachers to ensure a positive outcome for a child or adolescent. Without this rounded input and knowledge, there will be an incomplete picture. There are many issues facing children and adolescents of today, especially those living in rural and remote areas – as a health care provider, the orthoptist needs to be aware of the child as a whole, not just as an orthoptic patient.

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Prenatal Factors in Infantile Strabismus

Authors:
Maria Stamos,
MAppSc,GradDip(Neurosciences),DipAppSc(Orth), DOBA
Linda Santamaria, MAppSc, DipAppSc(Orth), DOBA
Cathy Mccarty, PhD, MPH
Catherine Devereux, MAppSc, BEd, DipAppSc(Orth), DOBA
Ian Story, PhD, BBSc(Hons)

Institution:
School of Orthoptics, La Trobe University

Address for Communication:
Maria Stamos-Pritchard
Geelong Private Hospital
Suite 12, Level 5, Ryrie Street, Geelong

ABSTRACT

Purpose:

To identify any common prenatal maternal factors influencing pregnancy that may predispose infants to develop infantile strabismus.

Methods:

A case control study was designed to evaluate the risk factors for strabismus. A set of exclusion and inclusion criteria was established for the cases and controls. The participating practices included fourteen private practices and three public hospitals throughout Victoria. Infants with infantile strabismus were recruited to the study on a voluntary basis as they presented to the various ophthalmic practices and hospitals. The control group participants were obtained from five Maternal and Child Health Centres. The mothers of the infants were given a pilot-tested questionnaire to complete. The questionnaire was made up of general questions relating to the mother and infant, 'masked' questions and specific questions related to the usage of alcohol, drugs and tobacco by the mother during pregnancy.

Results:

This study included 43 infants with strabismus and 100 controls. The strabismus group consisted of 37 cases of infantile esotropia and 6 cases of infantile exotropia. There were no known neurological deficits in either group. All infants were less than 12 months of age. There were several significant differences between the two groups. The most significant finding was that of parity, with 19% of infants in the strabismus group being the mother's first born, while in the control group 51% of infants were the mother's first born ($c_ = 13.0$, df = 1, p = 0.0003). More mothers from the strabismus group took medication prior to pregnancy compared with the control group, the incidence being 14% and 5% respectively ($c_ = 3.57$, df = 1, p = 0.06). More of the mothers in the strabismus group (63%) had a history of ever smoking (that is, past or current smoker) compared to the control group (47%) ($c_ = 3.00$, df = 1, p = 0.08) and more lived with a partner who smoked (40%) compared to the control group (22%) ($c_ = 4.4$, df = 1, p = 0.04). Strabismus in infants was not significantly associated with a family history of strabismus (p > 0.05).

Conclusion:

In this study, it appears that exogenous factors such as maternal smoking and medication usage, as opposed to endogenous factors, such as maternal and family ocular history and maternal medical conditions present prior to and during pregnancy, may have been more prominent factors in the development of infantile strabismus.

Key words: esotropia, exotropia, pregnancy, alcohol, smoking, drugs.

INTRODUCTION

Numerous theories exist as to the aetiology of some of the different types of strabismus, however the cause of early onset strabismus remains unclear. Some of the earlier theories which have been postulated include a faulty fusion faculty,[1] abnormal binocular reflexes,[2,3,4] hereditary or genetic factors,[5,6,7,8,9] birth complications and trauma,[9,10,11] viruses such as measles or whooping cough,[5,12,13] anatomical anomalies[12] and neurological problems.[10,14] Other associated findings include cortical damage or anomalies,[15,16] prematurity and low birth weight infants.[17,18,19]

The prevalence of infantile strabismus in the general population has been estimated to be between 0.1% and 2%[6,13,16,20,21] and between 13% and 60% in the mild to severe neurologically impaired population.[10,11,22,23,24,25] This finding suggests that central nervous system damage or involvement must play some role in the development of strabismus. Infants included in this study had no known general health or neurological problems, but may have had some subtle undetectable central nervous system dysfunction that could account for the development of strabismus.[15,20]

It has been hypothesised that early abnormal development of the visuomotor system and the influence of prenatal factors, particularly in the area of environmental and toxic effects, appear to indicate some causal relationship with strabismus. Prenatal toxic risk factors for the development of strabismus have shown an association with alcohol intake[25,26,27] tobacco smoking[28,29,30] and drug usage[28,31,32,33] during pregnancy. These studies however differ in many aspects, making a definite causal relationship difficult to determine, with some authors choosing to study one variable, while others have looked at the effects caused by multiple variables.

The aim of this research was to study the mothers of infants with infantile strabismus in order to compare prenatal factors in a strabismic population with a 'normal' control population.

METHOD

Two groups of infants were involved in this study, a group with strabismus and a control group without a strabismus. Ophthalmic practices and major public hospitals throughout Victoria were approached to recruit the strabismus group. They included 14 private practices and three hospitals (the Royal Children's Hospital, the Royal Victorian Eye and Ear Hospital and the Geelong Hospital). The control group participants were from five Maternal and Child Health Centres from the Geelong

region. Ethics approval was sought and obtained from all three public hospitals and from the La Trobe University Human Ethics Committee.

A set of exclusion and inclusion criteria was established for each group of subjects. All the infants in both groups were less than 12 months of age. Infants were excluded from both groups if there was any known neurological problem, if they were born at less than 36 weeks gestation or if they had a birth weight of less than 2500 grams. All the infants in the strabismus group had infantile strabismus, which had appeared during the first 6 months of life and was not the result of any underlying ocular or systemic condition. All the infants in the control group had no evidence of strabismus.

A specially designed pilot-tested questionnaire was used to collect data for this study. The questionnaire was designed with three main types of questions. First, a group of general questions related to the mother and her personal particulars such as age, weight and nationality. Second, a group of specific questions related to the mother and infant, such as the infant's gender, gestational age and birth weight, birth history including delivery type, current and/or prior birth complications as well as the planning of the pregnancy. Questions regarding eye problems in the mother or the immediate maternal and paternal family were included. Maternal medical history prior to or during pregnancy and subsequently, medications taken prior to and during pregnancy were noted. The tobacco smoking history of the mother and her partner and the alcohol and drug usage history of the mother formed part of this section of questions. The third group of questions included were 'masked' questions. These were included to reduce the perceived emphasis of the outlined relevant questions and included such topics as tea and coffee intake, regularity of exercise and working history during pregnancy.

Identical questionnaires and instructions were given to both groups. Participants were instructed to answer all the questions after reading and completing the Informed Consent form. Once written consent was obtained from the mothers, the infants were examined. The tests performed on both groups of infants, included corneal light reflex test, near cover test, ocular movements and a 20 dioptre prism reflex test. An approximate assessment of visual function was obtained, where possible using '100s & 1000s' and/or 'smartie' test placed at approximately 20 centimetres from the infant's face. The presence or absence of amblyopia was assessed by noting any objection or not to cover of either eye. Direct and consensual pupil responses were observed. The participants in the strabismus group also underwent cycloplegic refraction by an ophthalmologist in order to complete a full ophthalmic examination.

The statistical analysis package used in this study was SPSS for windows, version 6.1. Univariant analysis of the results was performed first for each variable using t-test for continuous data, Pearson's Chi-square and Fisher's exact test for categorical data. Following this, any significant finding(s), which included all factors with $p < 0.10$, were further analysed, in order to assess association between groups, using multivariant analysis - Odds Ratio (OR) with 95% confidence intervals (CIs). Backwards logistic regression was used to determine the final significant independent risk factors for strabismus at $p < 0.05$.

RESULTS

The strabismus group consisted of 43 infants with strabismus and the control group consisted of 100 infants without strabismus. The strabismus group consisted of 37 cases of infantile esotropia and 6 cases of infantile exotropia. The characteristics of the infants and their mothers are listed in Table 1.

For family history, the mothers were questioned regarding any history of eye problems, rather than a specific question on strabismus. The strabismus information was then extracted from the data. No mothers from the strabismus group and only one mother from the control group reported strabismus. The 21% incidence of strabismus reported among family members of the strabismus group was higher than the control group (11%) but not significantly different (see Table 2).

In the strabismus group, only 8 infants were the mother's first born (19%), while in the control group 51 infants were the mother's first born (51%), a statistically significant difference between the groups (see Table 2). Using multivariant analysis to control for 'ever smoked', 'live with smoker', medical condition prior to pregnancy and medication prior to pregnancy, this remained statistically significant with an Odds Ratio value of 4.83. Table 2 provides a summary of the independent risk factors analysed in this study and Table 3 shows the multivariant analysis of the independent risk factors.

In the strabismus group, medical conditions in the mothers prior to pregnancy were reported more frequently with an incidence of 19%, while the incidence in the control group was 8%, a borderline significant difference between the two groups (see Table 4). Medical conditions during pregnancy however were similar in each group (see Table 2).

More mothers from the strabismus group took medication prior to pregnancy compared with the control group (see Table 4), the incidence being 14% and 5% respectively, which was a borderline significant difference between the two groups. Using multivariant analysis to control for 'ever smoked', 'live with smoker', parity and medical condition prior to pregnancy, the Odds Ratio (OR) for medication taken prior to pregnancy for the groups was found to be statistically significant with a value of 4.1.

More of the mothers in the strabismus group (63%) had a history of ever smoking (that is, past or current smoker) compared to the control group (47%), which proved to be a borderline significant finding. This was statistically significant using multivariant analysis to control for 'live with smoker', parity, medical condition prior to pregnancy and medication prior to pregnancy. A statistically significant finding between the two groups was that more of the mothers of infants from the strabismus group (40%) lived with a partner who smoked compared to the control group (22%). The majority of these partners smoked indoors as opposed to outdoors. In the strabismus group the incidence was 26% compared with 11% in the control group, which was a borderline significant difference between the two groups. The type of smoker that the mother's partner was reported as included non-smoker, light, moderate or heavy smoker. This was defined by the mothers. In the strabismus group more partners were moderate (28%) or heavy (7%) smokers compared to the control group (11%, 2%, respectively), which was a statistically significant difference. The smoking behaviours of the mothers during pregnancy are shown in Figure 1.

Table 1. Infant and maternal characteristics

Risk factors	Strabismus cases n (%)	mean (SD)	Control cases n (%)	mean (SD)	t-test	p-value
Child birth weight	43(100)	3.51(0.66)	100(100)	3.45(0.52)	0.47	0.64
Child gestation	43(100)	38.9(1.83)	100(100)	39.2(1.40)	-1.15	0.26
Maternal age	43(100)	30.9(4.27)	100(100)	30.5(4.43)	0.54	0.59
Pre-pregnancy weight	39(90.7)	66.7(12.66)	99(99)	65.7(9.24)	0.48	0.64
Child's age at presentation	43(100)	6.72(2.21)	100(100)	7.68(2.06)	-2.42	0.018

Table 2. Summary of risk factors and univariant analysis

Risk factors	Cases=43 n (%)	Controls=100 n (%)c_	Pearson's Chi-square	p-value	df
Gender of infant					
- male	18 (42)	50 (50)	0.80	0.37	1
- female	25 (58)	50 (50)			
Exercise	33 (77)	76 (76)	0.62	0.73	2
Coffee	25 (58)	60 (60)	0.04	0.84	1
Tea	28 (65)	65 (65)	0.0002	0.99	1
Strabismus					
- self	0 (0)	1 (1)			
- family	9 (21)	11 (11)	2.47	0.12	1
Birth complications	12 (28)	21 (21)	0.81	0.37	1
Planned pregnancy	35 (81)	81 (81)	0.003	0.96	1
Lifestyle change	16(37)	30 (30)	0.72	0.4	1
Parity	8 (19)	51 (51)	13.00	0.0003*	1
Medical condition					
- prior	8 (19)	8 (8)		0.08+±	
- during	16 (37)	38 (38)	0.04	0.84	
Medications					
- prior	6 (14)	5 (5)	3.57	0.06±	1
- during	34 (79)	72 (72)	0.42	0.52	1
Consumption of alcohol					
- first trimester	18 (42)	53 (53)	1.49	0.22	1
- second trimester	14 (33)	33 (33)	0.001	0.97	1
- third trimester	17 (40)	44 (44)	0.25	0.62	1
Ever smoked - mother	27 (63)	47 (47)	3.00	0.08±	1
Smoked					
- first trimester	13 (30)	21 (21)	1.41	0.23	1
- second trimester	8 (19)	14 (14)	0.58	0.45	1
- third trimester	8 (19)	15 (15)	0.36	0.55	1
Mother lived with smoker	17 (40)	22 (22)	4.36	0.04*	1
Where partner smoked					
- outdoors	6 (14)	11 (11)			
- indoors	11 (26)	11 (11)	5.34	0.07±	2
Partners smoking type					
- light	2 (5)	9 (9)	-	-	-
- moderate	12 (28)	11 (11)	9.15	0.03*	3
- heavy	3 (7)	2 (2)			

Fisher's exact test result
* significant at $p < 0.05$
± borderline significance at $p < 1.0$

Table 3. Multivariant analysis

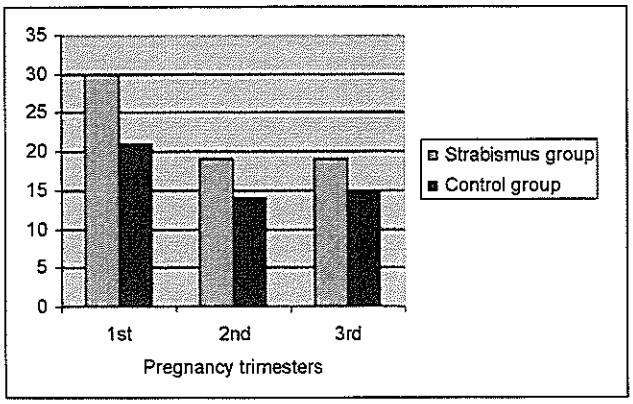
Risk factors	Strabismus cases N=43 n (%)	Controls N=100 n (%)	Odds Ratio (OR)	95% Confidence Intervals
Ever smoked	2 7(63)	47 (47)	2.7	1.19, 6.03
Medication -prior	6 (14)	5 (5)	4.1	1.06, 16.13
Parity	8 (19)	51 (51)	4.83	1.96, 11.88

Table 4. Medical conditions and medication taken prior to pregnancy for the strabismus and control groups

Medical conditions prior to pregnancy	Strabismus group N = 43	Medication taken	Control group N = 100	Medication taken
Asthma	1	1	1	2
Depression	1	1	1	1
Schizophrenia	1	1	-	-
Diabetes	1	1	-	-
Migraine	1	1	-	-
Rhinitis	1	1	-	-
Thyroid disease	1	1	-	-
Heroin addiction	1	1	-	-
Hypertension	-	-	2	2
Heart problems	-	-	1	-
Anaemia	-	-	1	1
Thalassemia minor	-	-	1	-
Addison's disease	-	-	1	-

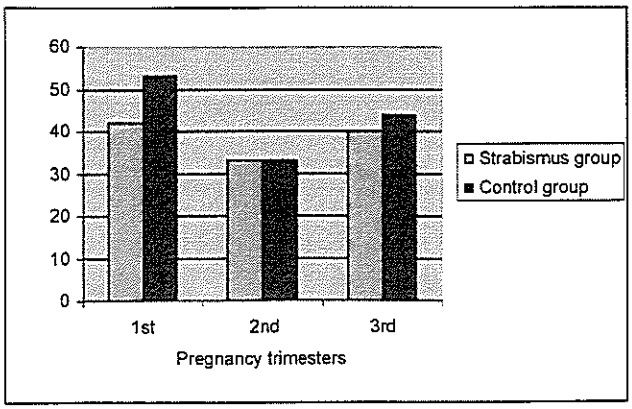
+ not mutually exclusive, some mothers in strabismus group used multiple medications

Figure 1. Cigarette smoking behaviours during pregnancy



Alcohol consumption patterns over each of the three trimesters of pregnancy were similar between the two groups (see Table 2). A trend noted in both groups was that the consumption of alcohol decreased during the second trimester, increasing again in the last trimester but not to the level of that in the first trimester (see Figure 2).

Figure 2. Alcohol consumption behaviours during pregnancy



DISCUSSION

The results of the present study suggest that exogenous factors such as maternal active and passive smoking and medication usage may have been more prominent factors in the development of strabismus among some of the infants, as these activities undertaken specifically during pregnancy were the only maternal underlying difference between the strabismus and control groups. As there was only one mother who reported a history of strabismus, it seems that maternal and family history was not a direct contributing factor for development of strabismus in this group, in contrast to other studies.[5,6,7,8,9]

An interesting and significant finding was that of parity, with only 19% of the infants with strabismus being first born, compared to 51% in the control group. This finding indicates that there is an increased incidence of a mother's infant developing strabismus after the first pregnancy. This has also been reported among studies of abnormal pregnancy outcome[38] and among studies of children with Fetal Alcohol Syndrome (FAS),[26,39,40] where there is an increased risk with subsequent pregnancies. Of the studies which reported parity as a possible risk factor for strabismus, no specific explanations were provided. Chew et al.[29] reported that parity was significant for esotropia. In contrast, Graham[41] and Podgor et al.[42] reported no relationship between the incidence of strabismus and the number of or positioning of siblings in a family.

Maternal age is an important factor to consider, as this would be expected to increase with the number of children. However, in this study the mean age of the mothers was similar in the two groups, which would indicate that many of the mothers of the strabismus group had their first child at a younger age. The control group therefore consisted of a higher proportion of older first-time mothers where perceptions of behaviours such as smoking, alcohol consumption and taking medications may have differed from younger first-time mothers. One limitation of the study that may influence parity was that the control group were from Maternal and Child Health Centres, where there is a higher attendance of first-time mothers. However, this would not explain the low incidence of first-born children with strabismus in comparison to the population. According to the Department of Human Services,[43] approximately 41% of infants were first-borns in 1999/2000. In the light of previous studies, further investigation is suggested to confirm this finding.

Medical conditions present prior to pregnancy occurred more frequently among the mothers in the strabismus group

compared with the mothers of the control group. Most of the conditions experienced by the mothers from both groups were chronic problems unrelated to pregnancy. No studies were found in the literature that looked at medical conditions present in the mother prior to pregnancy and the subsequent development of strabismus among their infants. Medical conditions during pregnancy occurred with almost equal incidence between the two groups.

In this study a significant difference between the groups revealed that it was more likely that the mothers from the strabismus group took medication prior to pregnancy as compared to the mothers of the control group. Strabismus as a consequence may be a result of medications taken prior to the knowledge of pregnancy when the mother's body was undergoing physiological change and adapting to pregnancy. This in turn may have resulted in changes to the properties of the different medications and also changes in the ability to control some of the medical conditions. Other influencing factors may have included the medical condition present, the range of medications taken and the small numbers of mothers that took medication in both groups. Medications taken during pregnancy however were not significantly different between the groups.

An association between strabismus and psychoactive drugs has been reported in previous studies.[31,32,33] Infantile exotropia has been reported as a common finding in infants with prenatal drug exposure.[31] In the present study, of the six infants with exotropia, there were three mothers who took medications; one antidepressants, one antipsychotics and the other methadone. These types of medications were not used by any of the mothers of infants with esotropia. However, one mother did use marijuana prior to her knowledge of pregnancy, giving birth to twins, one with esotropia. The reported effects of marijuana during pregnancy are inconsistent, with no convincing evidence to suggest smoking marijuana is harmful or teratogenic to humans or the fetus.[33,34,35,36] Methadone usage and the development of strabismus have been found to be associated in some studies.[32,37]

Both active and passive maternal smoking behaviours were found to be significantly different factors between the mothers from both groups. Of these, more of the mothers in the strabismus group were past or current smokers and/or lived with partners that generally smoked indoors. It is therefore possible that some of the infants during pregnancy may have been exposed to the effects of smoke directly via the mother smoking and/or passively via her partner.

The present study found that the majority of mothers from both groups smoked less than 15 cigarettes per day and so were classified as light smokers, as defined by other studies,[30,44] so a dose-response relationship with strabismus was not able to be established. There are conflicting reports on the dose-response relationship between smoking and strabismus, with one study reporting no relationship[30] and others finding heavy smokers, that is greater then 20 cigarettes per day, had a higher risk of congenital anomalies, including strabismus.[29,44]

Two of the six mothers of infants with exotropia smoked throughout pregnancy compared to only six of 37 mothers with infants with esotropia. Among women who smoked throughout pregnancy, an increased and statistically significant risk for esotropia has been reported[29,30] and an increased, but insignificant, risk for exotropia.[29]

In the present study, the higher incidence of the mothers' partners smoking in the strabismus group could have been an influencing factor in the development of strabismus. Of importance also is the finding that more of the mothers' partners from the strabismus group were moderate or heavy smokers, compared to the control group. This indicates possibly a greater risk of development of strabismus caused by the effects of passive smoking than the mother smoking.[45] The effects of paternal smoking and its passive smoking effects have been reported in the literature, with infants having lower birth weights and a higher risk of perinatal mortality.[46] Hakim and Tielsch[30] were the only researchers who looked at mothers exposed to secondary smoke via their partners and reported an increased risk of strabismus particularly esotropia, only when the mother smoked during pregnancy, but not if she was a non-smoker. It is still to be established whether abnormal outcomes are due to the pregnant mother's passive smoking or from direct damage to the paternal gene or sperm.[46] In conclusion, the fetus appears to be a passive smoker whether the mother or those around her smoke during pregnancy, which has detrimental consequences to development and health.[47,48]

In the present study the small numbers meant that it was not possible to further divide those who lived with partners who smoked into smoking and non-smoking mothers. Further investigation of passive smoking behaviours during pregnancy, whether in addition to active smoking or alone, would assist in further understanding this issue.

Alcohol consumption behaviours during pregnancy were similar in the mothers from both groups with no mothers consuming alcohol in large quantities or at 'at-risk' levels as defined by the Alcohol and Drug Foundation. In this study there were generally low levels of alcohol, smoking and medication usage by the mothers. Some mothers were multiple or concurrent users of these, all of which in high doses are known to be harmful to the fetus, making it difficult to attribute adverse effects to a single substance.

As all the questionnaire information concerning maternal and paternal behaviours was self-reported information after the infants were born, errors of under-reporting and recall bias may have occurred. Further studies involving test-retest reliability could clarify this result.

The findings of this study, particularly in relation to maternal behaviours and parity, suggest several possibilities. Known teratogenic behaviours such as smoking, consumption of alcohol and the taking of medication, undertaken by mothers both prior to and during pregnancy may affect the mother's body over a long period of time. The effects of these teratogens as a consequence may accumulate within the mother's system causing both physiological and genetic changes. These changes may have detrimental effects on the infants, the outcome or symptoms of which may remain relatively undetected in an initial pregnancy, but manifesting in subsequent pregnancies. Although these infants may not have major congenital malformations, they may present with minor abnormalities, including strabismus. What these changes are and how they produce these outcomes or consequences require further investigation. Paternal behaviours may also need to be addressed when considering conception and pregnancy outcomes in the future.

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Literature Review: Non Standard Vision Tests to Predict Functional Vision

Authors:
Jody Major, BappSc(ORTH)(Hons)
Neryla Jolly, DOBA (T), MA (Macq)

Address for Communication:
Neryla Jolly, School of Applied Vision Sciences
Faculty of Health Sciences
University of Sydney
PO Box 170, Lidcombe NSW 2141
AUSTRALIA

ABSTRACT

This literature review explores tests that demonstrate aspects of vision other than high contrast Snellen's acuity. The outcome from such tests may link to human performance in daily living tasks such as driving and mobility.

There are a variety of visual tests that demonstrate different visual skills these include night vision (Nyktotest, Mesotest, mesopic visual acuity), glare sensitivity (Mesotest, Nyktotest, brightness acuity tester [BAT]), contrast sensitivity and visual attention (useful field of vision [UFOV]). Results reported in literature suggest links between reduced performance and decreased daily living skills. For example the UFOV test is predictive of crash involvement among elderly populations. Each test will be explained and their application to driving or general mobility will be explored.

This paper raises the possibility of examining vision by using methods that will result in the practitioner being able to predict the impact of vision defects on human performance.

Keywords: functional vision, driving, night vision, mesopic vision, glare sensitivity, contrast sensitivity, useful field of vision.

INTRODUCTION

Functional Vision

Conventional clinical tests identify abnormalities such as congenital defects, refractive errors and the development of pathology. These tests include visual acuity, visual fields, ophthalmoscopy, slit lamp, intra ocular pressure, and ocular motility assessment. Some patients gain a response for all of these tests that is within the defined normal standard but may complain that their vision is not adequate for specific tasks. The tasks that patients identify include life skills such as driving at night or in glare, reading, performing occupational tasks, the recognition of faces and facial expressions, sewing and sporting activities.1 For the purpose of this paper, vision that supports life skills or quality of life will be defined as functional vision.

Functional vision can be affected by defects of the visual apparatus as well as normal environmental changes. The visual apparatus requires clear optical media; full correction of refractive error; and the full integrity of the retina, fovea, and visual pathway.[1] If there is an anomaly of any of these factors, functional vision can decline and certain visual situations may become problematic to the individual. Changes in the environment can also alter the ability to see. "We know intuitively that given the appropriate set of [atypical] circumstances each of us with 20/20 vision will function as a visually handicapped individual. Thus, when a person is driving into the sun at dusk, or dawn, changes in contrast sensitivity and the effect of glare alter detail discrimination."[2] The environmental changes often cannot be avoided but the impact on functional vision can be increased by deficits of the visual apparatus. Identification of deficits in the visual apparatus and education of the patient can assist the patients' safety and comfort.

Functional vision can be assessed with a variety of methods not used in conventional clinical practice where the emphasis is disease detection and monitoring. The methods to test functional vision fall into broad categories of vision tests (1) under different light levels (night vision and glare sensitivity), (2) contrast sensitivity tests and the (3) Useful Field of View test. (4) Personal perception of driving ability has also been strongly linked to most of the vision tests described.[3]

A review of literature has revealed a range of tests that investigate different aspects of functional vision. These will now be discussed.

1. Tests under different light levels

1.1 Night/Twilight Vision

The quality of night vision is a very important factor for functional vision because it can affect a person's ability to cope in low light situations. Such functional aspects include driving at night, walking around the house at night or in low light levels and reading in reduced light levels. In reality most night vision activities involves a low light source and might be more accurately described as twilight vision. Twilight vision is the transition from photopic vision to scotopic vision.[4] Scotopic vision uses the rods whereas photopic vision uses the cones. The area in between where both the rods and the cones are contributing towards sight is called mesopic vision.[5] If you consider driving at night; some examples of low light sources would include overhead streetlights, car lights, city lights, headlights, the moon and residual sunlight during dawn and dusk. Twilight vision would also include the situation of driving a car in the country at night, without the moon being present, where the driver would increase the intensity of their own car lights using high beam.

Twilight vision can be degraded by refractive error, ocular pathology and age related changes.[6] The pathology can include cataracts, retinitis pigmentosa, glaucoma, and vitamin A deficiency.[6] Cataract's can degrade night vision by decreasing the contrast sensitivity, increasing myopia due to the changes in the refractive index of the lens, and monocular diplopia due to light splitting.[6] Retinitis pigmentosa specifically depresses the rod function of the retina and therefore the most common symptom is a failure to see properly in dim illumination.[6] Glaucoma decreases peripheral vision which is largely rod function thus the glaucoma patient may have difficulty with how well they see at night. Vitamin A deficiency can cause

night blindness because vitamin A is the main component of rhodopsin, which is essential to night vision.[6]

Twilight vision also described as mesopic vision can be tested with an array of instruments which are used around the world. Such tests include the mesopic vision test, Mesotest and Nyktotest.

1.1a Mesopic Visual Acuity or Twilight Visual Acuity

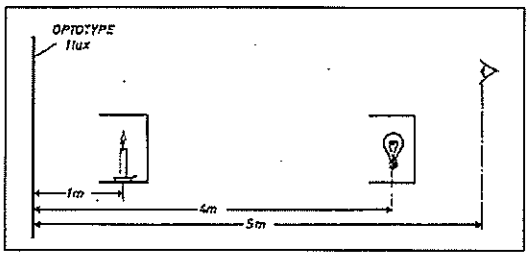

Fig 1. Set-up with stearin candle (1m) and incandescent lamp of 15W (4m) to obtain the necessary illuminance of 1 lux.[4]

Mesopic vision, which determines nighttime functional vision, can be assessed with a vision chart that has an illuminance of 1 lux. An illuminance of 1 lux can be approximately demonstrated by placing a 15-Watt light source, in a dark room, 4 metres from an optotype. An illuminance of 1 lux can also be achieved by placing a stearin candle 1 meter from an optotype.[4] Mesopic contrast vision can also be assessed using both the Mesotest and the Nyktotest. These two specific tests are mainly used in certain countries in Europe where there are laws for the minimum night vision that is required for driving. In Belgium the minimum driving standard for twilight (mesopic) vision is 6/30. Night vision decreases with increasing age and eye pathology.[7,8] It has been proven that drivers with reduced twilight vision are more frequently involved in accidents at night than those who fully satisfy the minimum requirement for visual functions.[9]

1.1b Mesotest II

Fig. 2 The Mesotest II by Oculus.[10]

The Mesotest II can assess mesopic contrast sensitivity and glare sensitivity. The patient has to identify the direction of the gap in the Landolt rings, which have an array of six positions. During the test the rings are presented in four different contrast levels. The affect that glare has on the individual is assessed by using a bright glare source pointed towards the eyes whilst performing the contrast test. The Mesotest II is especially useful when assessing a person pre/post IOL and refractive surgery. It complies with the standards for mesopic vision testing as set by the DOG (Deutsche Ophthalmologic Gesellshcaft [German Ophthalmological Society]).[11,12] Contrast sensitivity, as measured with the Mesotest, deteriorates in an age dependant fashion. Thus as contrast sensitivity decreases with age there is a logical link with reduced night driving ability. In a study by Scharwey the majority of persons over the age of 60 were not able to fulfil the criteria for night driving ability according to the recommendations of DOG.[8] The population studied revealed that nearly 40% of persons aged over 60 had reduced night driving ability.[8] A study by Rassow et al they found that even when surgically correcting a cataract with an IOL that approximately 60% of patients will not satisfy the standard for night driving as set by DOG.[7]

1.1c Nyktotest

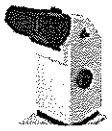

Fig. 3 The Nyktotest by Rodenstock.[13]

The Nyktotest is an instrument that tests contrast sensitivity in twilight, both with and without a bright glare source from the side. The Nyktotest is similarly configured as the Mesotest II. Both tests present a target with varying contrast levels. Again this can be used both with and without a glare source. This test helps to detect uncorrected or insufficiently corrected defective vision. It also can detect night myopia.[14,15] This test has been used in a variety of research papers investigating the pathology which affects night vision.[3,7,16-19] The Nyktotest has been recommended to be used only as a screening test because it has a lower reliability result than similarly corresponding night vision assessor's such as the Mesotest.[17] In a study by Katlun it was found that even 1 year after PRK the number of patients with reduced contrast sensitivity using the Nyktotest (with and without glare) was higher than before PRK. It is important to note that before PRK was performed there were a number of patients with decreased contrast sensitivity (both with and without glare) who did not satisfy the requirements for driving in Germany as set out by the DOG.[16]

Testing twilight vision with the following tests: mesopic visual acuity, Mesotest and Nyktotest, has revealed a greater knowledge about functional performance when driving. It also brings into focus the importance of discussing the possible impact on functional vision prior to any refractive procedures.

1.2 Glare Testing

Vision tested in the clinical setting is usually performed at optimal conditions with high contrast. A patient with a normal visual acuity standard of 6/6 can still complain of visual problems related to glare.

Cassin defines glare to be caused by a "light stimulus not near a fixation target that can raise the threshold of the macula and decrease visibility of the target."[20] Glare is produced by the scattering of light caused by an obstruction in the light's path to the macula.

There are two types of glare including discomfort glare and disability glare. Discomfort glare is defined as the sensation caused by glaring light sources.[21] Disability glare is defined as the reduced visual acuity because of stray light entering the eye (scattered light) due to a glare source.[21] Therefore, discomfort glare corresponds to a sensation, whereas disability glare considers visual function.[21]

Visual acuity can reduce considerably in the presence of bright light when there are opacities in the media. Media opacity includes cataract, corneal scar, protein particles in the anterior

chamber (flare), or postoperative radial keratotomy.[20] It has been shown (P<0.0001) that with an increase in age there is a general increase in the susceptibility to glare associated with identifiable eye pathology.[22]

Disability glare can be noticeable to the person in bright sunlight, or whilst driving at night.[20] This can cause the person, who for example may be playing sport in bright sunlight, to be affected and unable to see what is happening around him or her. Driving with the low sun as a glare source can also be disruptive to a persons driving. The glare sensitive person may also experience problems whilst driving a car at night. The lights from oncoming traffic may hinder or prevent the driver from reading valuable road signs and more importantly seeing what is directly in front of the vehicle on the road. An individual with a small central cataract may be seriously affected when participating in sports and driving, due to the pupil contracting, which increases glare susceptibilty.[6]

There are a variety of glare testers on the market including the conventional Brightness Acuity Tester (BAT), the Nyktotest, Mesotest and the Straylightmeter.

1.2a Brightness acuity tester

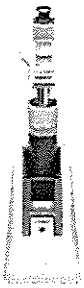

Fig. 4 Brightness Acuity Tester by MARCO Ophthalmic, Inc[23]

The Brightness Acuity Tester (BAT) is a small device with a spherical bowl, which is placed over one eye and shines light into the eye, it has a hole which allows the user to view the vision chart. The BAT can determine significant visual loss attributed to a bright light that creates a small pupil and glare.[23] The test should be performed four times: at normal, lowest, medium and high illumination. Initially the test is performed without any other light source to test normal visual acuity. The second time it is performed with the BAT at its lowest illumination, which is equivalent to a room with normal overhead lighting. On the third occasion the BAT is performed at medium light levels, which is equivalent to being outdoors on a cloudy day. On the fourth and final time the BAT is set at its highest setting, which is equivalent to being outdoors with direct overhead sunlight.[24] No more than one line of difference should occur in patients without ocular opacities or distortions. There are three results that can be interpreted from performing the BAT. They include a response which is worse, better or has not changed. No change in acuity suggests that there are no significant ocular opacities or distortions present. An improvement in vision is associated with residual refractive error or non-central cortical cataract due to the pinhole effect associated with a constricted pupil. A decline in acuity is commonly associated with opacities in the ocular media.[20]. A deterioration in acuity due to disability glare as tested with the BAT may identify a future need for treatment.

1.2b Nyktotest and Mesotest

The Nyktotest and the Mesotest both assess glare sensitivity whilst performing a contrast sensitivity test. The Nyktotest and Mesotest are specifically designed to simulate driving conditions at night/twilight by having the patients dark adapt for 10 minutes and then measuring the contrast sensitivity, with and without a bright glare source on the side of oncoming cars. This test mimics the conditions of driving at night and has been used in an array of research papers investigating vision function when driving. It was found that glare sensitivity deteriorates with increasing age and in the presence of cataract, IOL implants[25] and PRK[16]. For these conditions glare is a problem when driving at night and causes difficulty viewing objects in the line of their sight when affected by glare.[8]

1.2c Straylightmeter

Fig. 5 The Cataract quantifier also known as the C-Quant (the new Straylightmeter).[26]

Disability glare has been directly linked to the amount of stray light that is present in the eye. The Straylightmeter measures the amount of retinal stray light in the eye, as a basic physical quantity.[27] The measurement does not rely on the patient's perception and is more objective than the Nyktotest and Mesotest. The Straylightmeter works by flashing a circular light source on and off at about 8 hertz, this is our peak flicker detection. The test is separated into two frames. One in which the stray light is on and the other in which it is off. The person is seeing two images one on top of each other in a flickering fashion. If the centre of the image is black in both frames, the subject will perceive a flicker on the fovea. This is due to light, which will only reach the fovea when the stray light is on. The centre black dot is continually watched and the patient continually increases the amount of light on the "off frame's" centre target, until they stop perceiving a flicker sensation. The amount of compensation light required on this centre target is equal to the stray light that is scattered in the eye.[21]

In a study by Van Rijn et al.[28] several contrast sensitivity tests were evaluated for repeatability, validity, and discriminative ability. The clinical assessors included conventional contrast sensitivity based tests such as the Mesotest and the Nyktotest and the non-conventional new stray light meter. The study was conducted to particularly discriminate between clinically evaluated cataract patients from non-cataract patients. The results from the study showed that the Straylightmeter was able to discriminate, between those patients who suffered with early cataracts to those who did not have any cataracts, better than the conventional contrast sensitivity based glare tests.[28]

Testing glare sensitivity with the conventional Brightness Acuity tester, the Nyktotest and Mesotest, and the Straylightmeter has revealed a greater understanding as to the importance of the impact that glare has on functional vision. Disability glare in most cases is due to opacities in the ocular media, and these tests quantitatively identify the reduction in vision under glare conditions that occurs with the associated pathology. Glare testing reveals an important area for identifying and treating the offending pathology to improve quality of life.

2. Contrast Sensitivity

Contrast sensitivity is becoming an increasingly more accurate way of measuring functional vision. Contrast sensitivity refers to the ability of the visual system to distinguish between an object and its background. Some people may complain of visual dysfunction but still achieve "normal" vision on the Snellen visual acuity chart. This is because visual acuity assesses the smallest letter that is observed at maximal contrast. However our visual world contains many low contrast visual cues that are more difficult to see should there be a deficiency in the visual mechanism. A high level of contrast sensitivity is important for the identification of objects whilst driving under certain conditions such as in fog, whilst raining, at night, or during dusk. It can also be of assistance for normal living skills and daily tasks such as reading speed or performance, mobility, perception of faces, computer work, occupation activities and sport.[29]

Contrast sensitivity can be affected by various pathology including cataracts, glaucoma, macular degeneration, retinitis pigmentosa and rod-cone dystrophy.[6,20] To achieve a high level of contrast sensitivity full correction of ametropia is necessary, as well as a healthy visual system. The blur produced by ametropia hinders the recognition of objects.1

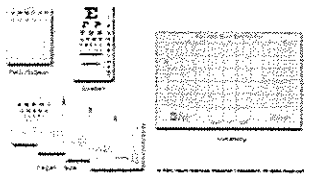

Fig. 6 Different contrast sensitivity tests including the Pelli-Robson, Snellen, Regan, and the FACT by Ginsburg.[30]

There are two ways of testing contrast sensitivity including sine-wave type tests (e.g. VISTEC and FACT); and letter charts (Pelli-Robson and Regan charts). Contrast sensitivity using sine wave gratings at different frequencies is the most sensitive method for testing contrast sensitivity.[31] The low frequencies (wide bars) tests sensitivity to very large objects whilst the higher frequencies (narrow bars) measure the sensitivity to viewing very small objects. Each test frequency starts at a high level of contrast which diminishes progressively with subsequent circles.[32] Therefore the design of the chart illustrates how well a person is able to see varying object sizes (frequency) in variable light levels (contrast).

There are two types of letter contrast sensitivity charts, including the Pelli-Robson and the Regan contrast sensitivity charts. The Pelli-Robson determines the contrast required to read large letters of a fixed size. The chart uses size 6/30 letters which decrease in contrast only.[20] This test has only a limited value because it eliminates the variable of spatial frequency. Although this test has its short comings it does have the added advantage of presenting the familiar format of a lettered chart.[33]

The Regan chart uses a standard acuity chart at different contrast levels. It includes four separate charts for absolute, high, intermediate and low contrast levels. Although this may seem like it would be the superior type of contrast sensitivity test (using letters of different sizes and contrast levels), it has been seen as time consuming to perform and converts to a person being able to perceive only the sharp edges of a scene.[30]

Driving a motor vehicle at night is a time when street signs, and other visual cues are at a very low contrast level. Ball et al, reported older drivers with a diagnosis of cataracts and macular degeneration typically avoid driving at night more than those free of ocular disease.[34] Considering these conditions reduce contrast sensitivity it is not surprising that they restrict themselves to driving only in high contrast situations. Contrast sensitivity is a useful tool in assessing a person's function vision during the night and under low light level situations.

3. Useful field of View

The Useful Field of View (UFOV) is a computerised product developed in the United States of America that evaluates visual attention under a variety of cognitive demands. The test is designed to calculate the visual field area over which a driver can process rapidly presented visual information. This test has been incorporated into studies examining the relationship between aging, cognitive decline, and driving ability. It is also able to predict the possibility of the future likelihood of crashes by an individual.[35] The test is particularly relevant when determining the possibility of crash occurrences by older drivers,[36-38] or those affected by multiple sclerosis.[35]

The UFOV is conducted by subjecting the candidate to a series of sub-tests. The first is a Visual Information Processing test, the second is a divided attention test and the final is a selective attention sub-test.

The sub-tests are performed by presenting the candidate with a simple object which they can relate to, such as a car or a truck. Objects must be identified by the candidate after a brief exposure to the shape. As distracting visual stimuli is added, the tasks become increasingly more complicated. The sub-tests allow the examiner to develop individual performance scores, which are measured in milliseconds. This allows a tester to determine the length of time required by the candidate to process information accurately. The performance score, an essential measure of this temporal latency, indicates that a high score relates to poor performance by the candidate, which suggests that the candidate is more likely to have impaired driving ability.[35]

Owsley[37] investigated a large group of older drivers for eye health, visual sensory function, the size of the UFOV, and their cognitive status. The participants were stratified using age and crash frequency. This research found that those individuals "with visual sensory impairment, cognitive impairment, and/or a constriction in the size of the useful field of vision were at a greater risk for crashes than were those without these problems."[37]

The UFOV is a useful and new approach to assessing vision and its impact on driving ability. This test is a break away from the traditional measurement of visual sensory function, because the UFOV encompasses perceptual and behavioural aspects to assess visual function with a strong influence on driving ability and crash rate. The computer operated software is available in Australia on a user pay basis. It is not endorsed by the Drivers License Authority in Australia.

4. Personal Perception (Perceived Driving Disability)

One method of detecting functional vision is to examine the personal perception of visual ability via a questionnaire. The Perceived Driving Disability assessment is a questionnaire specifically designed to give a score on how a person perceives a certain situation when driving.[3] Situations that are included in

the questionnaire are perceived driving disability at night and perceived driving disability in unfamiliar places. Perceived driving disability at night was calculated by subtracting daytime scores from nighttime driving question scores. The perceived driving disability in unfamiliar places was calculated by subtracting the scores of driving in familiar places from those in unfamiliar places.

Van Rijn et al[3] performed a study in which he used this questionnaire's responses and different visual assessments to find out the relationship between a persons perception of driving disability and the scores on the vision screening tests. Vision tests that were used in the study by Van Rijn et al[3] included visual acuity, contrast sensitivity (Pelli-Robson chart), visual field (HVF analyser), mesopic contrast sensitivity and glare sensitivity (Mesotest II and Nykotest 300).

The perceived disability when driving at night and in bad weather conditions, were found to specifically relate to the scores on the Nyktotests and the Mesotests. This is particularly evident in subjects with "good" visual acuity (6/7.5 or better). Although visual acuity indicates how well a person can see, it does it only in the sense of a high contrast environment. Outside the clinical environment, the visual world is bombarded with low contrast objects. When the perceived driving disability questionnaire was compared to clinical responses, it clearly demonstrated the importance of alternative visual assessments for drivers. In this study no correlation was found between perceived driving disability at night and visual acuity scores for near and distance. Whilst not a formal clinical test personal perception provides excellent feedback about driver coping skills.

CONCLUSION

Functional vision is an exceedingly broad and yet highly documented area. A number of non-standard vision tests are available which when combined with conventional clinical tests are able to provide a better understanding of a patient's ability to see under different conditions.

The Mesotest II and Nyktotest can assess mesopic contrast sensitivity and glare sensitivity. These tests are useful in determining a patient's ability to recognise objects at night and under glare situations. The mesopic Visual Acuity test can also provide valuable data of how well a patient can see under night or twilight conditions. These tests are mainly used in Europe where there are legally enforceable nighttime driving standards. However currently in Australia there are no such driving standards in place.

Glare testing methods such as the Brightness acuity tester and Straylightmeter can offer a valuable insight into how a patient responds in a high glare situation. This is important to recognise as this can be potentially missed during standard clinical tests. Our ability to measure how a patient is able to respond to glare is important, as glare has been found to significantly hinder a patient's ability to see under relevant light conditions. Additionally the Mesotest and Nyktotest test can also be used to provide glare data on a patient. The main reason for experiencing glare susceptibility and its impact on vision is due to opacities in the ocular media. Thereby indicating a need to identify and treat these pathologies early.

Contrast Sensitivity is useful in testing patients in the clinical environment to explain why they are complaining of visual difficulties despite normal visual acuity. This test allows the clinician to determine exactly how the patient is affected by their declining optical media.

The Useful Field of View determines a driver's ability to observe and comprehend the busy visual situations that the driver is assaulted with when driving a motor vehicle. The result from this test has been matched with crash rate. This is a useful tool because it encompasses visual function and cognitive ability with a strong impact for crash rate whilst driving.

Finally questionnaires such as the Perceived Driving Disability questionnaire can provide a score, which was designed to determine how a person perceives a certain situation whilst driving. The results of this correspond to the patient's results on certain clinical tests versus the patients perceived ability to see.

Vision under ideal clinical conditions does not provide the full story of how an individual copes in real life. A range of tests are available that examine patient skills in different light levels and environmental circumstances that can better inform the practitioner of the patients ability to cope in life. Recommendations can then be made on adapting to certain conditions or to intervene with specific treatment.

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Abstracts from Royal Australian and New Zealand College of Ophthalmologist's Squint Club 2004

Phenotype and Genotype in a large Australian family with Congenital Fibrosis of Extra-Ocular Muscles (CFEOM) type 3.

Jon B. Ruddle, David A. Mackey

Royal Victorian Eye and Ear Hospital, Melbourne, Australia

Aim: To review the clinical characteristics and determine the gene localisation for Congenital Fibrosis of Extra-Ocular Muscles type 3 (CFEOM-3). Recently genes for CFEOM type 1 and 2 have been discovered. CFEOM-1 individuals harbour heterozygous missense mutations in a kinesin motor protein encoded by KIF21A. CFEOM-2 results from homozygosity for the ARIX gene that is a transcription factor crucial for the oculomotor and trochlear nuclear development in mice. CFEOM type 3, a subtype that predominantly affects vertically acting muscles has been linked to chromosome 16 in 2 families. The gene has not yet been identified, but hypothesized to be a downstream target of ARIX.

Method: We extended examination to 28 members of previously described Victorian family (Gillies et al, *Ophthalmology* 1995). Each underwent ophthalmological examination and provided DNA for genetic analysis.

Results: Affected individuals have variable ptosis, primary gaze with hypo and exotropic position and marked restriction of vertical eye movements bilaterally. Horizontal eye movements were variably affected. A minority of family members had asymmetrical involvement. Jaw-winking an example of ocular miswiring was seen in a young member of the pedigree.

Conclusion: Identification of the gene for CFEOM-3 will increase our knowledge into the aetiology and management of squint.

Eye muscle surgery for Thyroid Eye Disease related glaucoma

Justin Mora

Purpose: To describe two patients with progressive thyroid eye disease related glaucoma who could not be controlled medically. Based on the belief that it is the tight rectus muscles which cause the pressure elevation in this condition early recession surgery was undertaken principally to aid glaucoma control. The outcomes will be discussed.

An unusual complication of squint surgery?

Error! Bookmark not defined., **Mater Children's Hospital, Brisbane Ken Nischal, Great Ormond Street Hospital, London**

We present a case of a child with presumed microbial necrotizing scleritis complicating routine strabismus surgery, who was referred to us for definitive management. The patient was treated aggressively with systemic antibiotics, and the globe's integrity was successfully restored with a scleral patch graft.

Necrotizing scleritis associated with surgery is briefly reviewed.

40 Cases of strabismus treated with Botox

Lionel Kowal, Marshman, Sahare
Melbourne

Summary

- 77% (n=31) in office Botox
- most 2.5 – 5u (thyroid -- 20u)
- EMG control
- Repeated if no 'take' or inadequate result @ Dr's discretion
- 23% (n=9) : intraoperative injection
- Fairly reliable for residual/consecutive ET
- Not reliable in Graves' and XT
- Effective as adjunct to surgery in large angle esotropia (Tychsen)

Functional assessment of preschoolers at Royal Blind Society - who do we see and why do we see them?

Marion Rivers, Paediatric Orthoptist, Royal Blind Society, Sydney.

Over 350 children have had a functional vision assessment in NSW and the ACT over the last 2 years by the Orthoptist from Royal Blind Society (RBS). All of these children have corrected vision of 6/18 or worse and the majority have vision of less than 6/36.

Cortical Vision Impairment (CVI) is the main cause of vision impairment under the age of 6 referred to RBS. The most common ocular cause of vision impairment is ocular cutaneous albinism (OCA).

Children are assessed using standard visual acuity charts including preferential looking charts and Logmar charts when possible. When formal acuity readings are not possible, responses over a period of time to various everyday objects and situations gives valuable information to parents, carers and therapists.

The aim of the Children's Service program at RBS is to facilitate each child's development and independence through their life stages. Vision information is the first goal in this process. It allows early decisions to be made as to whether vision substitution or vision enhancement techniques will be used to facilitate learning and socialisation.

This paper will examine the causes of visual impairment for children under the age of 6 referred to RBS . Functional vision assessments and the implications of the information gained will be discussed.

Refractive surgery in strabismus patients

Lionel Kowal, Burton Kushner, Ravindra Battu
The private eye clinic, Melbourne

Diplopia and worsening of misalignment are undesirable complications of refractive surgery in known strabismics.

This presentation will teach how to assess strabismus patients for refractive surgery.

Why a Medline search is not enough

A/Prof Elaine Cornell
School of Applied Vision Sciences University of Sydney

In 1907 CR Judd published a sixty five page monologue in the Yale Psychological Review of observations that he had made of vergence eye movements. To do this, he placed a small marker ('Chinese white') on the corneas of his subjects' eyes, and then photographed their movements during convergence and divergence using a 'kinetoscope' camera. By observing the markers in each frame of the film, and knowing the average exposure time, calculations were made of the position of each eye at the same point in time, and the approximate speed of the eye movements.

Despite this relatively crude method, he documented and described some of the complex patterns of saccades and vergence movements that have been more recently 'discovered' using modern precise measurements of eye movements.

Consequences of Amblyopia on education, occupation and long term vision loss.

Brian Chua and Paul Mitchell
Blue Mountains Eye Study, Sydney

Aims: To describe the effect of amblyopia on education, occupation and 5-year incident vision loss.

Methods: 3654 participants aged 49 years or older participated in the Blue Mountains Eye Study (BMES I, 1992-1994), and 2335 (75·1% of survivors) were re-examined (BMES II, 1997-1999). All participants underwent detailed eye examination. Amblyopia, defined as best-corrected visual acuity of less than or equal to 6/9 and not attributable directly to any underlying structural abnormality of the eye or the visual pathway, was identified in 118 participants (3·2%) in BMES I, of whom 73 were re-examined in BMES II. Occupation and educational classifications used definitions of the Australian Bureau of Statistics.

Results: The mean age of persons with amblyopia seen at baseline was 67·0 years. Amblyopia did not affect lifetime occupational class (p=0·5), but fewer persons completed higher university degrees (p=0·05). In persons with amblyopia, there was an increased risk of 5-year incident visual impairment in the better-seeing eye worse than 6/12, relative risk (RR) 2·7, 95% confidence interval (CI) 1·6-4·6. One of eleven (9·1%) persons with amblyopia showed significant improvement in visual acuity in the poorer-seeing eye after a 2-line (10 logMAR letter) vision loss in the better-seeing eye.

Conclusion: This study further documents the longitudinal history of amblyopia using population-based data.

A retrospective review of the associations between amblyopia type, age, compliance and referral patterns.

Brian E-G Chua , Kim Johnson, Frank Martin
The Children's Hospital at Westmead

Background: To review presenting ages, referral sources, amblyopia type and compliance in children attending a typical public hospital ophthalmology clinic with no formal amblyopia screening program in place.

Methods: 127 children attending the outpatients clinics of The Children's Hospital at Westmead for amblyopia management between January 2001 and May 2003 were reviewed. Presenting age, amblyopia type, referral source, treatment prescribed and compliance achieved were analysed using means, 95% confidence intervals, and Mantel-Haenszel _2 statistic.

Results: General practitioners and paediatricians provided most referrals. The mean presenting age was 32.9 (95%CI: 29.0-36.9) months. We found no significant association between presenting age and amblyopia type (_2=6.00, p=0.11, 3d/f), but a trend was found with deprivation amblyopes identified earliest, and pure anisometropic amblyopes latest (Mantel-Haenszel _2=5.65, p=0.02, 1d/f). Compliance to patching did not differ significantly between sexes or amblyopia type, with calculated aggregate compliance 67.3% (95% CI: 59-75%) for males, and 66.3% (95%CI: 60-73%) for females, and (_2=3.61, p=0.3, 3d/f) between amblyopia types. Compliance was better amongst younger and older children, and worst when aged 15-30 months. There was no association between patching compliance and treatment duration.

Conclusion: Amblyopia is a preventable form of blindness. A multidisciplinary approach must be taken. Resources and education should be targeted at general practitioners and paediatricians who have the greatest opportunities to perform amblyopia screening. Teachers are an important resource in identifying cases missed at previous informal screening opportunities. Amblyopia treatment must be intensified and individualised between the ages of 15-30 months when compliance is poorest.

How much amblyopia do we miss – the state of paediatric vision screening in NSW, 2004.

Sue Silveira & Liane Wilcox

As all eye health care professionals are aware, normal visual development is dynamic, with defined critical periods. It is also easily disturbed. The aim of vision screening is to detect signs of disturbance, so diagnostic testing can be implemented.

Sadly much of the paediatric vision screening services in NSW have been systematically dismantled, due to area health service prioritizing funds into areas other than screening programs.

This presentation aims to update eye health care professionals regarding the state of paediatric vision screening in NSW, suggestions for possible solutions, and proposed RANZCO and OAA guidelines.

Diplopia and the on road experience

Neryla Jolly
The School of Applied Vision Sciences, Sydney University

Case studies will be presented that relate clinical assessment of diplopia with driving performance. The outcome will be discussed and linked to strategies that support safe driving.

Heritability of Duane Syndrome

Lindsey W. Scotter, Benjamin J. Connell, Robin M. Wilkinson, Julie M. Barbour, Johan L. Poulsen, M. Gabriella Wirth, Rowan W Essex, Ravi Savarirayan, David A. Mackey.

Our research into Duane syndrome started 2002 as an offshoot of the Strabismus Inheritance Study of Tasmania (SIST) and as part of a collaboration with the Engle Laboratory.

Two separate groups of patients were evaluated. 1) Families with features of Infantile esotropia were identified through the SIST. Clinical details of participants and their families were reviewed for any cases of Duane syndrome. 2) Cases of Duane syndrome were identified through the clinical diagnostic database at the Royal Children's Hospital, Melbourne and private ophthalmology clinics in Melbourne and Tasmania. Previous medical notes were reviewed and family history of strabismus noted. All affected individuals were invited for re-examination in cases where a positive family history of strabismus was reported, siblings, parents and other family members where appropriate were invited to be examined for signs of Duane syndrome or infantile esotropia.

Results: 133 families from the SIST were reviewed but no "pure" families of Duane syndrome were identified. Two families with Infantile esotropia have several affected members with Duane syndrome. 219 Duane syndrome patients were identified via the diagnostic databases, but only 40 agreed to be involved in the study. Of those, 21 had a family history of ocular motility disorders but only two of these families had multiple cases of Duane syndrome.

Conclusions: There is clinical overlap in families with Duane syndrome and Infantile esotropia.

For more information about the genetic research:
www.tch-genomics.org/research/engle
lscotter@rveeh.vic.gov.au

Anaesthesia for Strabismus surgery

David Baines
Dept of Anaesthesia, The Children's Hospital at Westmead

Anaesthesia for strabismus surgery in paediatrics is practically limited to general anaesthesia.

Anaesthetic techniques may vary, but can be divided into a spontaneously breathing technique or a technique using muscle relaxants and positive pressure ventilation. The advent of the re-inforced LMA has provided a safe and effective means of controlling the airway for this type of surgery, with the potential for decreasing the complications associated with endotracheal intubation.

Traction on the extra-ocular muscles commonly results in vagal stimulation and a resulting bradycardia – the well-recognised oculocardiac reflex. Paediatric cardiac output depends significantly on heart rate, and avoidance of bradycardias is seen as important. Although this reflex tends to decay with time, my approach is to treat the patients prophylactically with a vagolytic agent such as atropine.

Although strabismus surgery is not extraordinally painful, it is undoubtedly significantly uncomfortable. Post-operative analgesia can be provided by a combination of pre-operative medication, intra-operative narcotics and post-operative oral analgesics. The optimum analgesic regimen is unknown, as is the place of adjuvant local anaesthetic techniques, with each anaesthetist and each surgeon having their own ideas.

Strabismus surgery is well-recognised for its potential for causing post-operative nausea and vomiting (PONV). It is important to identify other risk categories, such as a previous history of PONV, and a history of motion sickness. Management of this problem includes possibly anxiolytic pre-medication, intra-operative intravenous fluids, drug therapy and information and reassurance. Drug therapy can be multimodal, with a steroid (dexamethasone) and 5 HT3 antagonists being used.

The newer anaesthetic agents in general have fewer side-effects and are better tolerated than the older agents. Muscle relaxants with less cardiovascular side effects, better predictability of their duration of action and less reliance on metabolism and renal excretion might offer advantages. Volatile agents such as desflurane offer a more rapid onset and offset of action due to their physico-chemical characteristics, and might also offer an improved cardiac effect profile. Disadvantages might include increased airway reactivity and cost.

Outcomes of Strabismus Treatment in Children with Cerebral Palsy

Renee Tierney
Orthoptist, Children's Hospital Westmead

Strabismus occurs in children with Cerebral Palsy in 30-52.5% of cases. This study aims to investigate the outcomes of strabismus treatment in these children. Looking at whether the ocular alignment appears cosmetic, visual acuity equal, functional binocular visual acuity is present demonstrating effective treatment. The study will look at whether any of these indicators are obtained and whether the type and severity of Cerebral Palsy has an impact on this outcome.

This study is ongoing and thus only preliminary results will be presented. The results will focus on the patients that have undergone surgical intervention for strabismus.

Botox or Surgery?

Maree Flaherty
The Children's Hospital at Westmead Sydney

The pros and cons of botox as an alternative to conventional squint surgery for congenital esotropia will be discussed.

Ocular Myasthenia in a nine year old boy.

Dr Catherine Dunlop, Newcastle, Australia.

Juvenile autoimmune ocular myasthenia will be discussed using a case study. A nine year old boy presented with a left superior oblique palsy. Eighteen months later he developed a left inferior rectus palsy.

Clinical features, which increase the suspicion of ocular myasthenia will be discussed. The prognosis will be contrasted with adult myasthenia

ABSTRACTS from British and Irish Orthoptic Journal 2005

Vergence adaptation – a phenomenon of normal binocular vision.

Alison Y Firth

Aim: To describe vergence adaptation and how it may impact on clinical practice.

Method: A literature based essay is presented, which includes a review of published work over the last 7 years and older literature as appropriate.

Results: Vergence adaptation is a normal phenomenon which occurs in the presence of binocular single vision to induced concomitant and incomitant deviations. It may be affected by age and practice. It may mask larger deviations than those initially seen during clinical testing and may be of significance in the aetiology of some forms of strabismus.

Conclusion: Vergence adaptation has previously been acknowledged as being important in the maintainance of comfortable binocular vision. Consideration of the phenomenon is useful in explaining many observations seen during orthoptic practice.

Clinical assessment of stereopsis and its functional significance.

Hayley Morris; Anna R O'Connor; M Gail Stephenson; Maureen Mitchell; Gary J Price; Susan Anderson BSc

Aim: To review the efficacy of near and distance stereotests in current use and to question the functional benefits of stereopsis based on current evidence.

Methods: A literature review was carried out to analyse the current reports of what is a normal level of stereopsis and how and why this varies according to the test used. In addition the role of stereopsis in many aspects of life is evaluated.

Results: The values reported for the normal limits of near stereoacuity vary greatly with only a weak correlation. Some of the variation can be attributed to test difficulties, such as monocular cues, or the population tested. There is no consensus as to whether near or distance stereoacuity are equal or vary and if so which is best. In terms of functional ability stereopsis has been shown to be beneficial in many areas such as academic ability, driving and sports.

Conclusions: The values reported for stereoacuity continue to pose questions with regards to the best approach for screening and clinical care. With tests now available to assess stereoacuity in the distance it is anticipated that knowledge of conditions, and subsequent treatment, will improve in conditions such as intermittent distance exotropia. In response to the question 'do we need stereopsis' the answer is that it is beneficial but not essential, however it may be more pertinent to ask 'what is the precise nature of the benefit?'

Congenital Ocular Motor Apraxia.

Morag McIndoe

Aim: To report the ocular and general features of a group of patients with Congenital Ocular Motor Apraxia (COMA).

Methods: Twenty-one cases of COMA who presented to the clinic, were seen following a review of the clinical database or were siblings of presenting cases are reported. All had full paediatric, orthoptic, and ophthalmic examination including video recording of head movements and determination of family incidence. Thirteen cases had radiological examination.

Results: All cases showed the typical clinical features of COMA. In addition there was a variety of orthoptic, ophthalmic, paediatric and radiological findings. Half of the group had myopia, which ranged from –0.50 to –19DS. There were seven familial cases of COMA, which were associated with consanguineous marriage.

Conclusion: Patients with COMA may have a wide spectrum of ophthalmic and general abnormalities. The presence of familial cases within the group supports the theory of a genetic basis for some cases of COMA.

Attentional Visual Field Analysis using Fastpac.

I Cunningham; PC Knox; FJ Rowe; AC Fisher

Aim: To investigate the effect of dividing attention using conventional automated perimetry in normal, healthy young and elderly subjects.

Methods: A Humphrey Visual Field Analyzer was modified by the addition of external lasers, which introduced a task additional to the standard threshold field test by presenting red targets at fixation. Young and elderly subjects inexperienced in perimetry were recruited. Two standard 30-2 Fastpac visual fields were examined. Three attentional visual fields were completed which varied in difficulty. The number of targets at fixation decreased from 72 (high) to 48 (medium) and then 24 (low) in each attentional visual field. The effects on visual sensitivity were compared by dividing the central 30° degrees in four regions dependant on eccentricity. Accuracy, durations and manual response times in the different conditions were also compared.

Results: In high distraction conditions elderly subjects showed reduced visual sensitivity whereas young subjects had similar sensitivity compared to sensitivity for standard visual fields. As the numbers of distractors was reduced visual sensitivity was shown to improve for both groups. The duration time to complete the attentional visual field increased for both groups compared to the standard fields but measures of accuracy were broadly similar in both standard and attentional visual field tests for both groups. The manual response times in the attentional conditions increased for both groups in attentional conditions.

Conclusion: The loss in sensitivity in high distraction attentional visual fields for elderly subjects, longer durations and increase in response time suggest that motivational or

cognitive status may have an impact on the interpretation of visual field results.

A National Survey To Assess The Prevalence Of Written Guidance For Occlusion And Practice Variation In The Treatment Of Amblyopia.

Sue Elliott

Aim: To assess the prevalence of written clinical guidance for occlusion treatment and variation in occlusion practice within Orthoptic departments in the United Kingdom (UK).

Method: A questionnaire was sent to every Orthoptic department in the UK. Questions asked about the existence of written guidance in departments and how this guidance had been developed. Subsequent questions asked about the treatment of amblyopia. Clinical scenarios of amblyopia were provided and departments had to indicate the occlusion in hours that would be prescribed.

Results: 190 of 240 questionnaires were returned; a response rate of 72%. 186 questionnaires were suitable for analysis. 66/186 (35%) of responding departments had written guidance for occlusion, 70 (38%) had some general department consensus on occlusion and 47 (25%) had no departmental consensus on occlusion and 3 (2%) declined to answer. Statistical analysis indicated there were significant differences between departments 'with guidance' and those 'without guidance', in the amount of occlusion prescribed if treating more severe amblyopia (6/60 vision). There were no significant differences in occlusion prescribed for less severe amblyopia (6/12 vision).

Conclusion: In the responding departments the prevalence of written guidance for occlusion treatment was low and there were significant variations in the amount of occlusion that would be prescribed. It is essential to have good quality, robust evidence on which to base clinical decisions.

Factors that influence the visual outcome in cases of infantile unilateral cataract.

Clare Dewsbery

Aim: To review retrospectively the records of a cohort of patients who presented before 6 months of age with unilateral cataract and identify factors that influenced the visual outcome.

Method: The records of children with unilateral infantile cataract, who had been examined since 1993 following the establishment of a new occlusion protocol, were reviewed. For analysis the children were divided into 2 groups, group A with visual acuity of 0.6 logMAR or better and group B with visual acuity of <0.6 logMAR. Factors examined were referral history, type of cataract, age at surgery, contact lens wear, ophthalmic complications, occlusion therapy, attendance record and distance from home.

Results: Thirty-two children met the inclusion criteria; 8 transferred to other hospitals leaving 24 cases for analysis. There were 11 (46%) children in group A with visual acuity ranging from 0.6 to 0.04 logMAR and 13 (54%) children in group B with visual acuity ranging from NPL to 0.74 logMAR. The median age at surgery was 8.5 weeks, (13 weeks group A; 7 weeks group B). There was a greater incidence of ophthalmic complications in group B. Nystagmus was present in 9 (37.5%) children, 8 of who were in group B and this was a significant factor in visual outcome, ($p = 0.013$). Compliance with the occlusion protocol was also a significant factor in visual outcome ($p = 0.016$). Further analysis indicated an association between occlusion compliance, visual outcome and distance from home, ($p = 0.035$)

Conclusion: A high incidence of ophthalmic complications, a delay in establishing daily contact lens wear and a failure to achieve 'good' compliance with occlusion therapy were associated with a poor visual outcome.

Pilocytic Astrocytoma of the Brainstem – a case report.

Claire Macintosh

Aim: To describe a case of pilocytic astrocytoma arising in the medulla, which presented as a sudden onset esotropia.

Method: A case is documented with history, neurological signs, orthoptic findings, and management. Pilocytic astrocytoma is discussed in relation to the literature.

Results: A small esotropia in a healthy 2 year old, presenting to a vision screening clinic, was the sole initial sign of a brainstem pilocytic astrocytoma. There was subsequent diagnosis of a mild VIth nerve palsy and development of other neurological signs including gaze evoked nystagmus and ataxia.

Conclusion: Pilocytic astrocytoma is a neuroepithelial tumour of the central nervous system, of low grade, occurring mainly in children and young adults and most commonly in the cerebellum. Pilocytic astrocytoma of the brainstem is much less common and carries a worse prognosis owing to difficulty in complete surgical resection. This is a rare condition, but the Orthoptist must remain aware that they may be the first point of referral in such cases and recognise signs indicative of urgent investigation.

A possible case of Heavy Eye Phenomenon

Morag McIndoe

Aim: To describe a case of possible heavy eye phenomenon and discuss the differential diagnosis.

Methods: Details are reported of a boy who presented at age 16 who had previously attended the Orthoptic department as a young child. Documentation of the case is presented including findings in childhood, findings at later presentation and photographic illustrations.

Results: The orthoptic findings for this boy when discharged at age 9 differed from the findings at age 16. At age 9 the patient showed good corrected visual acuity in each eye, good binocular functions and normal stereo acuity. At age 16, the patient had a variable right hypotropia, refractive error of -8.5/-1.25x5, left +0.25/-0.50x177.5 and axial lengths of right 26.22mm and left 22.86mm.

Conclusions: This is most likely a case of heavy eye phenomenon. Previous records are useful in determining the onset of the condition.

Recurrent Thyroid Eye Disease – A Case Series

EJ Wallace; CJ MacEwen.

Aim: To report recurrent thyroid eye disease (TED), which is unusual because the condition is considered a monophasic disease and recurrence is rarely reported.

Methods: A retrospective case note review was carried out on all patients who had attended the thyroid eye disease clinic in our hospital. Six cases with recurrence of their disease were identified. One case is presented in detail and the clinical findings of five similar cases are documented.

Results: Of the 6 cases, 5 were female. The average age at time of diagnosis with thyroid eye disease was 47 years and at the time of recurrence was 56 years. All were managed conservatively at their first presentation but 4 patients required radiotherapy to control the recurrence. Three patients required squint surgery after their disease reactivated. The most common operation for strabismus was an inferior rectus recession.

Conclusions: TED is considered to be a monophasic autoimmune disease with an initial active phase of progressive deterioration followed by a static phase with gradual improvement over the years. The cases presented show that the natural history of the disease does not always follow this conventional pattern and this is an important consideration when planning future management.

A Case Of Constant Esotropia With Diplopia Associated With Weight Loss In Anorexia Nervosa

B Manzouri; & GGW Adams

Aim: To describe the case of an adult female who presented with a constant esotropia with diplopia following the onset of anorexia nervosa, in who the control of her strabismus and diplopia improved as body weight was regained.

Methods: The orthoptic findings are presented and the outcome of treatment with botulinum toxin injection is reported.

Results: Botulinum toxin injection reduced the angle of deviation from 50_ base out (BO) for distance and 45_ BO for near, to 30_ BO for distance and 25_ BO for near. Post injection the patient reported a marked improvement in symptoms and experienced diplopia only when tired. Over time and in conjunction with weight gain the deviation was controlled to a microtropia with an associated latent component with demonstrable anomalous binocular vision.

Conclusion: This case shows the possible effects of anorexia on the balance of the oculomotor system with the onset of a convergent squint at a time of severe weight loss. Botulinum toxin injection under local anaesthetic may be the wisest and least invasive therapeutic choice in these patients, thereby avoiding a surgical procedure under general anaesthesia, which may be unsuitable in cases of anorexia.

Named Lectures, Prizes and Awards of the Orthoptic Association of Australia Inc.

The Patricia Lance Lecture

1988	Elaine Cornell (Inaugral)
1989	Alison Pitt
1990	Anne Fitzgerald
1992	Carolyn Calcutt
1993	Associate Professor Judy Seaber
1995	Dr David Mackey
1997	Robin Wilkinson
1998	Kerry Fitzmaurice
1999	Pierre Elmurr
2005	Kathryn Rose

The Emmie Russell Prize

1957	Margaret Kirkland	Aspects of vertical deviation
1959	Marion Carroll	Monocular stimulation in the treatment of amblyopia exanopsia
1960	Ann Macfarlane	A study of patients at the Children's Hospital
1961	Ann Macfarlane	Case history "V" Syndrome
1962	Adrienne Rona	A survey of patients at the Far West Children's Health Scheme, Manly
1963	Madeleine McNess	Case history: right convergence strabismus
1965	Margaret Doyle	Diagnostic pleoptic methods and problems encountered
1966	Gwen Wood	Miotics in practice
1967	Sandra Hudson Shaw	Orthoptics in Genoa
1968	Leslie Stock	Divergent squints with abnormal retinal correspondence
1969	Sandra Kelly	The prognosis in the treatment of eccentric fixation
1970	Barbara Denison	A summary of pleoptic treatment and results
1971	Elaine Cornell	Paradoxical innervation
1972	Neryla Jolly	Reading difficulties
1973	Shayne Brown	Uses of fresnel prisms
1974	Francis Merrick	The use of concave lenses in the management of intermittent divergent squint
1975	Vicki Elliott	Orthoptics and cerebral palsy
1976	Shayne Brown	The challenge of the present
1977	Melinda Binovec	Orthoptic management of the cerebral palsied child
1978	Anne Pettigrew	
1979	Susan Cort	Nystagmus blocking syndrome
1980	Sandra Tait	Foveal abnormalities in ametropic amblyopia
1981	Anne Fitzgerald	Assessment of visual field anomalies using the visually evoked response.
1982	Anne Fitzgerald	Evidence of abnormal optic nerve fibre projection in patients with Dissociated Vertical Deviation: A preliminary report
1983	Cathie Searle	Acquired Brown's syndrome: A case report
	Susan Horne	Acquired Brown's syndrome: A case report
1984	Helen Goodacre	Minus overcorrection: Conservative treatment of intermittent exotropia in the young child
1985	Cathie Searle	The newborn follow up clinic: A preliminary report of ocular anomalies
1988	Katrina Bourne	Current concepts in restrictive eye movements: Duane's retraction syndrome and Brown's syndrome
1989	Lee Adams	An update in genetics for the orthoptist: a brief review of gene mapping
1990	Michelle Galaher	Dynamic Visual Acuity versus Static Visual Acuity: compensatory effect of the VOR
1991	Robert Sparkes	Retinal photographic grading: the orthoptic picture
1992	Rosa Cingiloglu	Visual agnosia: An update on disorders of visual recognition
1993	Zoran Georgievski	The effects of central and peripheral binocular visual field masking on fusional disparity vergence
1994	Rebecca Duyshart	Visual acuity: Area of retinal stimulation
1995 – 1997		Not awarded

1998	Nathan Clunas	Quantitive analysis of the inner nuclear layer in the retina of the common marmoset callithrix
1999	Anthony Sullivan	The effects of age on saccadis mode to visual, auditory and tactile stimuli
2001	Monica Wright	The complicated diagnosis of cortical vision impairment in children with multiple disabilities
2005	Lisa Jones	Eye Movement Control During the Visual Scanning of Objects

The Mary Wesson Award

1983	Diana Craig (Inaugral)
1986	Neryla Jolly
1989	Not awarded
1991	Kerry Fitzmaurice
1994	Margaret Doyle
1997	Not Awarded
2000	Heather Pettigrew
2004	Ann Macfarlane

Paediatric Orthoptic Award

1999	Valerie Tosswill
2000	Melinda Symniak
2001	Monica Wright
2005	Kate Brassington

Past Presidents of the Orthoptic Association of Australia Inc

1945-6	Emmie Russell
1946-7	Emmie Russell
1947-8	Lucy Willoughby
1948-9	Diana Mann
1949-50	E D'Ombrain
1950-1	Emmie Russell
1951-2	R Gluckman
1952-3	Patricia Lance
1953-4	Patricia Lance
1954-5	Diana Mann
1955-6	Jess Kirby
1956-7	Mary Carter
1957-8	Lucille Retalic
1958-9	Mary Peoples
1959-60	Patricia Lance
1960-1	Helen Hawkeswood
1961-2	Jess Kirby
1962-3	Patricia Lance
1963-4	Leonie Collins
1964-5	Lucy Retalic
1965-6	Beverly Balfour
1966-7	Helen Hawkeswood
1967-8	Patricia Dunlop
1968-9	Diana Craig
1969-70	Jess Kirby
1970-1	Neryla Heard
1971-2	Jill Taylor
1972-3	Patricia Lance
1973-4	Jill Taylor
1974-5	Patricia Lance
1975-6	Megan Lewis
1976-7	Vivienne Gordon
1977-8	Helen Hawkeswood
1978-9	Patricia Dunlop
1979-80	Mary Carter
1980-1	Karen Edwards
1981-2	Marion Rivers
1982-3	J Stewart
1983-4	Neryla Jolly
1984-5	Neryla Jolly
1985-6	Geraldine McConaghy
1986-7	Alison Terrell
1987-8	Margaret Doyle
1988-9	Margaret Doyle
1989-90	Leonie Collins
1990-1	Leonie Collins
1991-2	Anne Fitzgerald
1992-3	Anne Fitzgerald
1993-4	Barbara Walsh
1994-5	Barbara Walsh
1995-6	Jan Wulff
1996-7	Jan Wulff
1997-8	Kerry Fitzmaurice
1998-9	Kerry Fitzmaurice
1999-00	Kerry Fitzmaurice
2000-1	Kerry Martin
2001-2	Kerry Martin
2002-3	Val Tosswill
2003-4	Val Tosswill
2004-5	Julie BArbour

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